The Engineer

LONDON, FRIDAY, JULY 11, 1941.

PUBLIC NOTICES

AUCKLAND HARBOUR BOARD, NEW ZEALAND

TEN FIVE-TON ELECTRIC SEMI-PORTABLE JIB CRANES

Tenders Will be Received at the Office of the Board at Auckland, N.Z., up till Twelve Noon on Tuesday, 30th September, 1941, for the SUPPLY and DELIVERY of TEN 5-TON ELECTRIC SEMI-PORTAL JIB CRANES, in terms of Specification No. 1152, which may be seen at the Office of the Board's Agent, Mr. C. R. Butters, c/o Messrs. H. H. Lloyd and Co., 2a, Guildhall Chambers, 31, Basinghall Street, London, E.C.2.

(Sgd.) W. B. SMITH,
Secretary.

7584

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ARTHUR V. RIDGWAY,
Town Clerk.

Town Hall,
Eccles.
July, 1941. 7603

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IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS 1940 No. 877

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The Engineer

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The Engineer

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Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

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For continuation of For Sale Advertisements see page 72

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A Seven-Day Journal

Essential Work Order for the Building and Civil Engineering Industries

IN a Journal note of June 20th we outlined the provisions of the Essential Work (Building and Civil Engineering) Order, 1941. Further particulars with regard to this Order and its application to the industries concerned have been recently published in a statement prepared by Mr. Ernest Bevin, the Minister of Labour and National Service, and Lord Reith, the Minister of Works and Buildings. The statement says that with a view to expediting the early completion of certain building and civil engineering works connected with the war effort, the Government has felt bound to ask the contractors and the operatives to institute or extend in the case of these works a system of payment by results, in order that the greatest possible rapidity of production may be secured. In putting forward the schemes the Government desires to give three assurances. First, should the representatives of the employers and operatives in the industries, as a result of negotiations, later reach an agreement between themselves on any adaptations of the present proposals, which in the opinion of the Government would be more effective in attaining the objects desired, then the Government will be prepared to reconsider the present scheme. Meanwhile any unauthorised departures from the present scheme will not be recognised. Secondly, with regard to those branches of the industries at present remunerated solely on a time rate basis, the Government scheme will constitute a recognised "change of practice." It will be operative only for the period of the war, except in so far as it may be continued by joint agreement. Thirdly, in no case will a worker under the new scheme receive less remuneration than he would receive for the same time worked under existing agreements or under the guaranteed pay provisions of the Essential Work Order. The Government proposes to begin scheduling forthwith certain urgent and vital works under the Order. Thereafter contractors who are engaged on these scheduled works will be asked to offer to the operatives engaged on all classes of excavating, concreting, stone hardcore and brickwork rates of wages which are set out in an appendix accompanying the Minister's statement. The rates will form the basis on which reimbursement will be made by the Contracting Department to the contractor and scheduling will be conditional on the rates being introduced and operated. The system is to be put into operation at once, but consideration will be paid to the necessity of arranging the change over on various works and sites in such a way as to involve the minimum of interference and inconvenience.

Another Italian Cruiser Sunk

IT was announced by the Admiralty on Sunday, July 6th, that British submarines operating in Mediterranean waters had gained important successes against Italian naval and mercantile ships which are engaged in carrying supplies and ammunition to the enemy armies and air forces now operating against us in Libya. On Sunday, June 29th, the report states, a submarine belonging to the Mediterranean Fleet, sighted two Italian 8in. gun cruisers, screened by four destroyers. The leading cruiser, which is thought to have been the "Gorizia," was struck by two torpedoes and, the magazine being hit, she blew up and sank. The "Gorizia" was a sister ship of the "Fiume," "Pola," and "Zara," which, it may be recalled, were all sunk in the Battle of Matapan on March 28th. When Italy entered the war she had seven of these large 8in. gun cruisers, all of which were completed between the years 1929 and 1934. The other ships are the "Bolzano," the "Trenti," and the "Trieste." The "Gorizia" was built and engined by Odero Terni-Orlando, being laid down in March, 1930, and completed in 1931. She had a standard displacement of 10,000 tons and a length of 559ft. 6in. overall, a beam of 67ft. 8in., and a draught of 19ft. 6in. She carried eight 8in. guns, twelve 3·9in., ten 37 mm. A.A., and eight 13 mm. guns; no torpedo tubes were fitted. The armour comprised 5½in. on the sides, 5in. on the turrets, 4½in. on transverse bulkheads, 3in. on the control tower, and 2in. deck. The propelling machinery comprised a twin-screw arrangement of Parsons geared turbines, with a designed output of 95,000 S.H.P., corresponding to a speed of 32 knots. Steam was raised in a battery of eight three-drum, oil-fired boilers, with a working-pressure of 300 lb. per square inch. The fuel tanks were arranged for a capacity of 1450 tons normally, or a maximum capacity of 2200 tons, giving a cruising radius of 3200 miles, at a speed of 25 knots. Two aircraft, with a launching catapult, were carried. Other ships torpedoed and damaged recently by our submarines, included an Italian armed merchant cruiser of about 9000 tons, which was hit by a torpedo and last seen in a crippled condition, and an enemy supply ship of about 6000 tons, which was torpedoed and subsequently sank. A further supply ship of about 8000 tons was torpedoed and sunk, and from the explosion was thought to be carrying munitions. The Italian steamship "Polindia," of about 1592 tons, which was carrying supplies to the Italian naval base of Cagliari, was torpedoed and sunk.

Southern Railway Locomotive "Union-Castle"

IT will be recalled that in an article which appeared in our issue of March 14th we described and illustrated the new Southern Railway 21C2 "Merchant Navy" class "Pacific" engine "Channel Packet," the first of nine locomotives designed for mixed traffic by Mr. O. V. Bulleid, the company's chief mechanical engineer. On Friday, July 4th, an interesting ceremony took place at Victoria Station, when the second engine, which has already been in service, was named the "Union-Castle" by Mr. Robertson Gibb, the late chairman and a director of the Union-Castle Mail Steamship Company, Ltd. The naming ceremony was presided over by Mr. R. Holland Martin, the chairman of the Southern Railway Company, who was accompanied by Mr. E. J. Missenden, the general manager, Mr. O. V. Bulleid, the designer of the engine, and many other members of the railway staff. In a few well-chosen words Mr. Holland Martin made reference to the long association of the Union-Castle Line with the railway and the port of Southampton. Mr. Robertson Gibb recalled the first sailing of the R.M.S. "Dane," a ship which inaugurated the African mail service on September 15th, 1857, and spoke of the fine fleet of fast motorships that the company now possesses, which until the war began always sailed from the port of Southampton. The new engines are all to bear a replica of the house flag of the shipping line concerned, and the following names have been chosen by reason of the long association of their companies with Southampton :—"Royal Mail," "Cunard White Star," "Canadian Pacific," "P. and O," "Aberdeen and Commonwealth," "Orient," "Shaw Saville," and "Blue Star." The principal particulars of the new "21C2" class of engine are as follows :—Diameter of driving, bogie and trailing wheels, 6ft. 2in., 3ft. 1in. and 3ft. 7in.; number of cylinders, three; piston diameter, 14in.; stroke, 24in.; adhesive weight, 63 tons; total weight of engine and tender, 140½ tons; grate area in square feet, 48½; total heating surface in square feet, 3317·8; normal tractive power, 37,500 lb.; tractive power per ton of adhesive weight, 595 lb.; tractive power per total weight of engine and tender, 267 lb.; tractive power per square foot of grate area, 765 lb.; and tractive power per square foot of total heating surface, 11·5 lb. As recorded in a recent issue, these new engines are being used to operate heavy mineral trains and are giving very satisfactory results.

Central Joint Advisory Committee on War Production

SPEAKING in the House of Commons on Tuesday, July 8th, Mr. Ernest Bevin, the Minister of Labour and National Service, announced that, in addition to the normal consultation, which goes on continually, both centrally and locally, between Government Departments and representatives of employers and workpeople, it has recently been decided to set up a Central Joint Advisory Committee to the Production Executive, composed of twelve employers' representatives nominated by the British Employers' Confederation and the Federation of British Industries, and twelve workpeople's representatives nominated by the Trades Union Congress General Council, with the following terms of reference :—"To advise the Production Executive on general production difficulties (excluding questions relating to wages and conditions in individual industries normally subject to joint negotiation) and on such other matters relating to production as may arise from the proceedings of regional boards or be referred to the Committee by the Production Executive." The members of the Central Joint Advisory Committee are :—Representatives of employers : Lord Dudley Gordon, Mr. H. F. Brand, Mr. John S. Boyd, Sir Charles Bruce-Gardner, Mr. Lewis Jones, Mr. W. A. Lee, Mr. Guy Locock, Mr. G. S. Maginness, Mr. A. McKinstry, Sir Alexander Ramsay, Mr. A. J. G. Smout, Sir J. Walker-Smith, and Sir John Forbes-Watson. Representatives of workpeople : Mr. C. H. Bagnall, Sir Walter Citrine, Mr. A. Conley, Mr. A. Deakin, Mr. C. Dukes, Mr. W. Elger, Mr. G. Gibson, Miss F. Hancock, Mr. H. N. Harrison, Mr. M. Hodgson, Mr. J. Kaylor, Mr. P. Paterson, and Mr. G. W. Thomson. The secretary is Mr. D. T. John, of the Production Executive secretariat, Offices of the War Cabinet, Great George Street, S.W.1. With regard to the Regional Area Boards, in order to obtain the benefit of the knowledge and advice of those officers in the regions who are directly or indirectly concerned with war production, membership of the Boards has been extended by the addition of the representatives of certain important official organisations. The work of each Board will be directed by an executive committee of the Board consisting of representatives of the three Supply Ministries, the Board of Trade, and the Ministry of Labour and National Service, with the Chairman and/or Deputy Chairman, and will be conducted in detail by sub-committees. Arrangements have been made whereby questions which in the view of the Boards merit consideration at the centre can be brought to the notice of the Production Executive without delay.

Chief Mechanical Engineer, Great Western Railway

THE Great Western Railway Company announces that Mr. Charles Benjamin Collett, who has been Chief Mechanical Engineer of the company since January, 1922, when he succeeded the late Mr. G. J. Churchward, retired on Saturday, July 5th, after forty-eight years of service. Mr. Collett was educated at the Merchant Taylors School, Charterhouse Square, and the City and Guilds (Engineering) College, South Kensington. He served his pupilship with the firm of Maudslay, Sons and Field, marine engineers, and entered the service of the G.W.R. in 1893, in the Swindon drawing-office. His promotion was rapid; he became assistant chief draughtsman in 1898 and technical inspector in 1900. In that same year Mr. Collett was appointed assistant manager of the works, and in December, 1912, he became manager. In May, 1919, he was made Assistant Chief Mechanical Engineer, and in January, 1922, followed Mr. Churchward in the office of Chief Mechanical Engineer. His contributions to locomotive design include the two new "Castle" and "King" classes of engine and extensive programme of locomotive standardisation. He also devoted time to the design of carriages and wagons, and played a great part in the equipping of the Great Western locomotives with automatic train control. Considerable extensions to the Swindon locomotive works were made in Mr. Collett's term of office. After close upon half a century of service, we hope that he may still enjoy many years of health and happiness in his well-earned leisure. Mr. Collett is succeeded in office by Mr. Frederick William Hawksworth, who has been his assistant for some years. Mr. Hawksworth is a Swindon man, and has already seen forty-three years of service in the Swindon works. He was apprenticed in 1898, and after working in the testing house became a draughtsman in 1905. In 1923 he was appointed assistant chief draughtsman and two years later chief draughtsman. In 1932 when Mr. W. A. Stanier left Swindon to take up the office of Chief Mechanical Engineer to the London, Midland and Scottish Railway Company, Mr. Hawksworth was appointed assistant to Mr. Collett, whom he now succeeds. He is a valued member of Council of the Institution of Mechanical Engineers.

The Glen Affric Power Scheme

FURTHER to our Journal note of June 27th and our leading article of last week on the Glen Affric power scheme, it is now announced that the second reading of the Bill in the House of Commons has been postponed. This course has been decided upon because the Committee of Privileges of the House has not yet reported upon the complaint which was recently referred to it arising out of the comments on the procedure at an earlier stage made in a letter to members of Parliament by certain opponents of the Bill. It is stated that more than one hundred members have now added their names to the motion tabled by Mr. Keeling for the rejection of the Bill. Last week the Grampian Power Company issued a statement to members of Parliament, in which it defends the scheme and stresses the benefits which are to be attained from its adoption. With regard to protecting amenities the statement says that provision is made in the Order for the preservation of the beauty of the scenery of the district in which the works and buildings will be situated. The company is required to furnish plans and particulars of the proposed works and buildings to an Amenity Committee, which will be appointed by the Secretary of State, and to comply with any reasonable recommendations of that Committee. It is further pointed out that any scheme for post-war planning will be absolutely unaffected by the works, but will have the advantage of an available electricity supply. The Order also contains permissive powers for the acquisition of the works by the Board of Trade after a period of years, should that course be deemed desirable in the public interest. The statement adds that the new power station will be situated in the northern area of supply of the Grampian Power Company and will draw its water power from lochs in Glen Affric and Glen Cannich upon lands wholly owned by an associated company. Local demands for electricity are increasing, and the greatest aid to real industrial development in the Highlands will, it is stated, be given by a supply of power available to meet promptly the demands of those manufacturers who may be prepared to establish industries in Highland districts.

Historic Accidents and Disasters

No. I

THE TAY BRIDGE—PART I

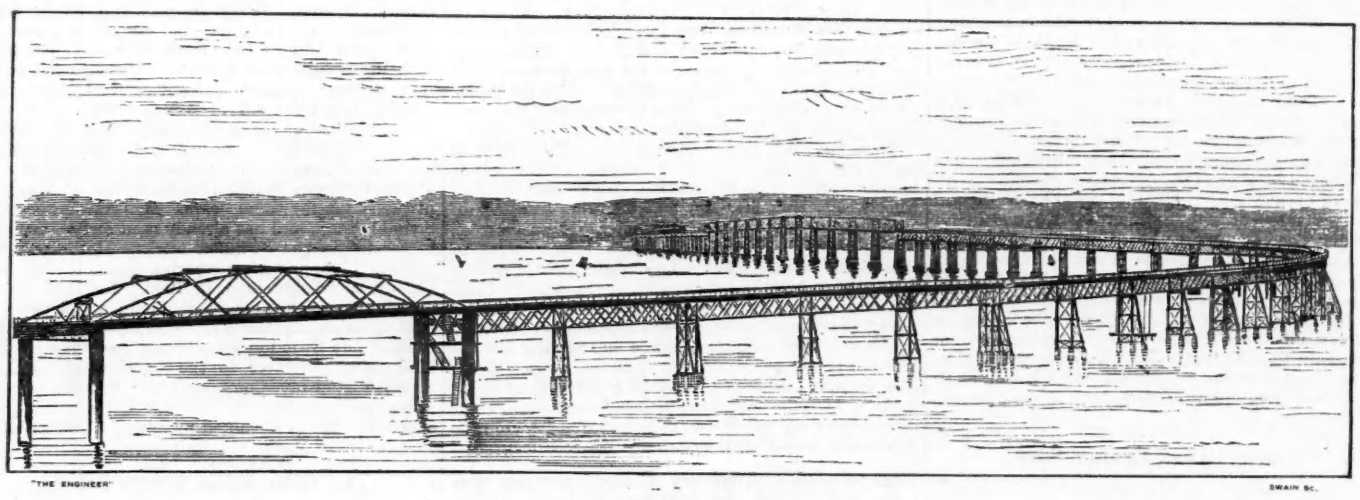
AT 4.15 p.m. on Sunday, December 28th, 1879, a train consisting of an engine and tender, one first-class, one second-class and four third-class carriages and a brake van left Edinburgh for Dundee. It never arrived at its destination. A great storm was raging at the time in the estuary of the Tay. To this day it is unknown whether the Tay bridge, which the train had to cross just before reaching Dundee, collapsed over a portion of its length under the train as it was passing over or whether it had already fallen before the train had reached it. When day dawned it was seen that thirteen of the spans had disappeared. Divers subsequently reported that they had found the remains of the train between the third and the fifth piers of the collapsed spans counting from south to north, the engine, tender and three coaches being between the fourth and fifth piers, and the rest of the train between the third and fourth piers. The train was believed to be carrying about eighty persons. All of them perished.

In order that we may comprehend as fully as possible the true nature of the disaster it is desirable at the outset to understand not only the technical characteristics of the bridge, but something of the personal characteristics of those who designed and built it. With the design of the bridge the name of Thomas Bouch will always be associated, but to assign responsibility for the disaster to him and him alone would be unjust. Bouch was born at Thursby, near Carlisle, in 1822. When he left school his father, a captain in the merchant service, apprenticed him to Mr. G. Larmer, a civil engineer, under whom he had excellent opportunities of becoming acquainted with railway engineering practice. His first important appointment was as resident engineer for the Wear Valley line. In 1849 he went to Scotland as manager and engineer to the Edinburgh and Northern Railway, subsequently known as the Edinburgh, Perth and Dundee Railway, and later incorporated in the North British Railway. In 1851 he set up in business on his own account as a civil engineer in Edinburgh and soon became extensively employed on numerous railway construction schemes in both Scotland and England. In addition, he designed a number of bridges and viaducts, his most important works of this kind, excluding the Tay bridge, being the Beelah and Deep Dale viaducts on the South Durham and Lancashire line and the Hownes Gill viaduct on the Stockton and Darlington line. His ability as a designer of bridges, it can be accepted, was not of a high order. He seems to have employed rough rule-of-thumb methods of procedure and to have "put a bit on here and taken a bit off there" more in accordance with instinct than with scientific reasoning. A notable instance of this kind—ominous, as we can now see, of what was to come—occurred in connection with his design for the Hownes Gill viaduct. Before accepting Bouch's design the railway company submitted it to Robert Stephenson, who altered it considerably in various directions, increasing its stability. Some of the piers were well over 100ft. high. Stephenson added abutments to them, increased their width and turned invert arches between them. It would also seem that Bouch on more than one occasion allowed his name to be associated with work which was really that of others. Thus the Beelah viaduct, to which we have referred, although constructed under his name, was really designed by Mr. Robert H. Bow. Again an early and successful scheme for establishing railway connection across the rivers Forth and Tay by means of train ferries was credited to him, but on his own admission the scheme had been suggested by a Mr. Grainger and had been carried out by a Mr. W. Hall.

Bouch was knighted by Queen Victoria shortly after her Majesty made her first crossing of the Tay bridge on her way to Balmoral. He died on October 30th, 1880, at the age of fifty-eight, his death saddened and probably hastened by the disaster which ten months previously had befallen the Tay bridge and by the abandonment of his project for bridging the Forth, on which he was engaged at the time of the disaster.

It will never be quite clear to what extent we are entitled to regard Bouch as the true designer of the Tay bridge. He was, as we have indicated, no mathematician. It might even be said that he made little use of calculations of any kind or recognised the need for them. One startling piece of testimony to that end is to be found in the course of his evidence before the Board of Trade Court of Inquiry into the disaster. Questioned regarding the allowance which he had made for the pressure of the wind on the bridge, he said that he "had not made any allowance for wind pressure specially." It would appear that he did not trouble himself with such questions, but left them to be settled by others, notably by a Mr. Stewart, a mathematician and engineer, who seems to have taken the principal share in the designing of the bridge as one of Bouch's assistants. In a written statement submitted to the Court of Inquiry Mr. Stewart revealed the fact that he had taken wind pressure into account in estimating the stability of the bridge. He had, he said, relied on Smeaton's table of wind pressure presented to the Royal Society in 1759, and to be on the safe side had taken the maximum probable pressure to which the structure would be exposed at 20 lb. per square foot, or nearly double Smeaton's figure for a very high wind. The fact that his assistant had actually made specific calculations on this subject without apparently his being aware of it suggests, to say the best of it, a certain lack of supervision on Bouch's part.

Were further evidence as to Bouch's ability as an engineer required, it could be obtained from the history of his proposed Forth bridge. In 1865 the North British Railway Company obtained parliamentary powers to bridge both the Tay and the Forth. Bouch was placed in charge of the design of both bridges. His original scheme for the Forth bridge contemplated a structure 11,755ft. long, including four 500ft. spans, at a point 5 miles above Queensferry. Borings at the site showed that the bed of the river for a depth of at least 120ft. consisted of soft silt, capable of sustaining without serious settlement only one-tenth of the load usually imposed on bridge piers. An experimental disc, 4ft. in diameter, loaded with 6 tons to the square foot, sank no less than 7ft. 7in. into the silt. On a foundation of this kind Bouch proposed to erect a bridge of the continuous girder type, a type which above all others requires immovable piers. The desired powers were obtained and in 1866 an experimental pier was begun. Fortunately, however, the financial embarrassment of the North British Railway Company led to the abandonment of the undertaking in 1867. In 1873 a second scheme was authorised. This scheme covered the construction of a stiffened suspension bridge at Queensferry with two piers on the island of Inchgarvie—that is to say, exactly on the site occupied by the existing Forth bridge erected to the designs of Sir John Fowler and Sir Benjamin Baker. Bouch's suspension bridge was to have two main spans, each 1600ft. long. The previous largest spans were those of the Britannia and Saltash bridges and measured 460ft. Parliament sanctioned the scheme without addressing a single question to its designer regarding the engineering character of the bridge, the manner of its erection or the stresses which would have been thrown upon it when erected and in use. Sir John Hawkshaw was asked to report on Bouch's design. He found it satisfactory in all respects, provided it was assumed that the pressure exerted by an extreme gale of wind did not exceed 10 lb. per square foot. With the fall of the Tay bridge renewed attention was given to the design of the Forth bridge. It was concluded that the wind pressure to allow for should be taken at 56 lb. instead of 10 lb. and that the stress in the suspension chains should be reduced from 10 tons to 8 tons per square inch. These and other alterations which it was thought desirable to make in Bouch's original design would, it was estimated, increase the cost of the bridge from £1,156,000 to at least £1,756,000. The scheme was abandoned as unsound.

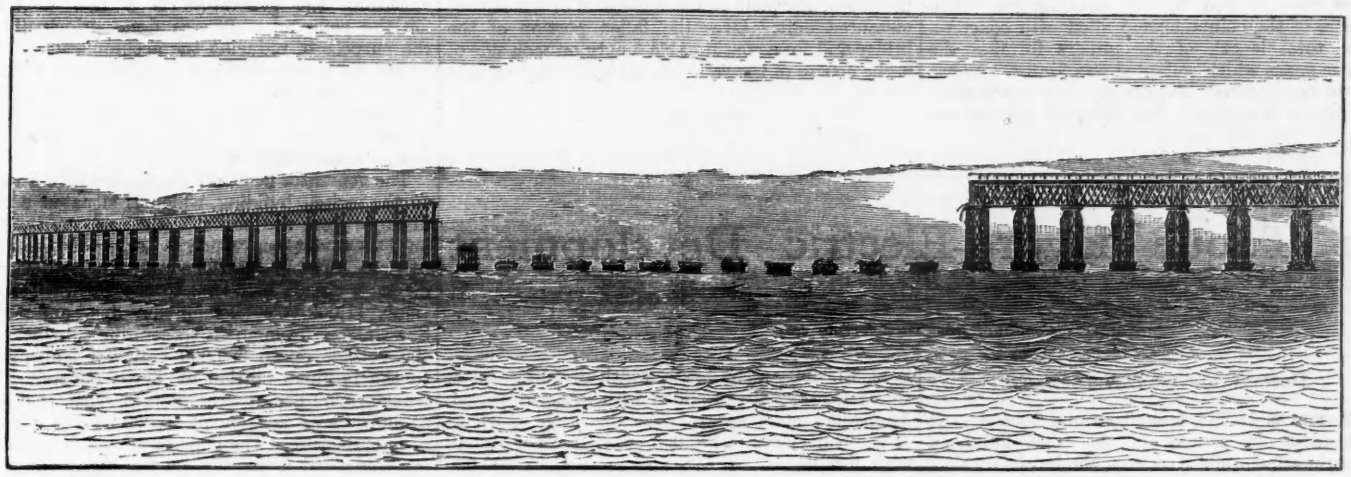


THE TAY BRIDGE FROM THE DUNDEE END

From these sidelights on Sir Thomas Bouch's character we may justly describe him as a recklessly ambitious engineer, possessing an incomplete knowledge of the forces with which he had to deal. In fairness to his memory, however, it must be added that in many respects he was at least as wise as his generation. We may be amazed at the carelessness, even the neglect, with which he treated the subject of wind pressure, but if he took the pressure corresponding to an extreme gale of wind at 10 lb. per square foot and assumed that it would act solely on the vertical area of the structure on the windward side and normally to the length of the bridge, he would be more or less justified in treating it as a secondary matter, consideration of which might well be left out of attention. In these respects many other engineers of his generation would have found no stone to cast at him.

The fall of the Tay bridge awoke engineers in this country and abroad to the unscientific way in which bridges had previously been designed. The revolution which the disaster originated in bridge building theory and practice was profound. It was Sir Thomas Bouch's unfortunate fate to be associated with the particular mishap which led up to the revolution. It might equally well have been the fate of some other of his contemporaries. In no respect is the change of outlook which the disaster produced better exemplified than in connection with engineers' views on the subject of wind pressure. Typical of this change is the record of the opinions held by the Astronomer-Royal of those days, Sir George Airy. In 1873, when he was

consulted as to the maximum wind pressure likely to be experienced over a span of the projected Forth bridge, he stated that it would probably not exceed 10 lb. per square foot. During the course of the Tay bridge inquiry in 1880, however, he expressed the view that all calculations for a proposed structure such as that which had collapsed



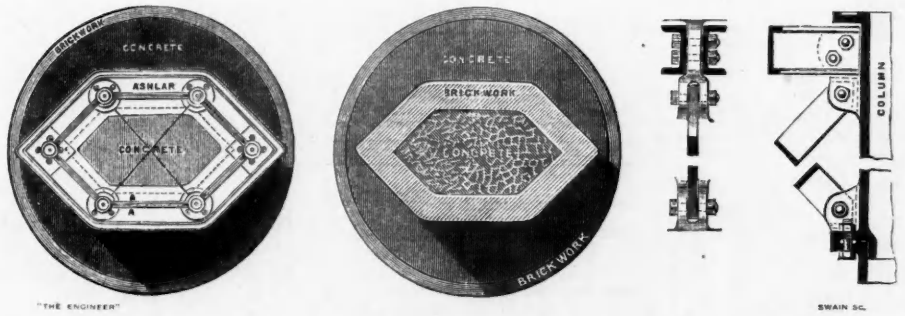
THE BRIDGE AFTER THE DISASTER

should be based on the assumption of a wind pressure of 120 lb. per square foot. He had to be shown his own report of 1873 before he could recall ever having placed the wind pressure allowance as low as 10 lb. By so much, therefore, can even an Astronomer-Royal be wise after the event.

If the history of the bridge on the design side was an unhappy one, it was no happier on the construction side. The original contract for its erection was awarded to C. de Bergue and Co., of London, Manchester and Cardiff, the contract price being £217,000. In May, 1874, following the death of Mr. de Bergue, the completion of the work was placed in the hands of Hopkins, Gilkes and Co., of Middlesbrough. Very considerable difficulties had been encountered during the earlier stages of erection and to overcome them and also to hasten and cheapen the completion of the structure the design was modified by Bouch in several major respects.

The design of the bridge as originally planned is on record in fairly full detail, but the alterations which were subsequently made were so numerous and important that the original plans are not of much value to anyone studying the disaster. No complete and accurate description of the bridge as it existed at the time of its collapse has ever been published. A paper read by Mr. Gilkes on November 6th, 1876, before the Cleveland Institution of Engineers is perhaps the most authoritative source of information concerning the bridge as finally constructed. That paper, however, was written a good two years before the bridge was completed and is known to contain a number of inaccuracies and to omit some important facts. It may be taken that from the time the bridge was begun until it was finished all concerned, engineers and contractors alike, were making compromises to overcome the difficulties encountered. Without the least hesitation the design of the bridge was modified during the progress of the work for any reason thought sufficient. These modifications included radical changes in the construction of the piers and alterations in their positions. If it was found that a pier could not be placed precisely at the point intended its site would be altered and the length of the girder changed to suit the new span. Trouble, too, was experienced with the methods employed for constructing the piers and erecting the girders upon them. On at least two occasions during the earlier stages of the work serious fatal accidents occurred, one of them involving the collapse of a portion of the structure.

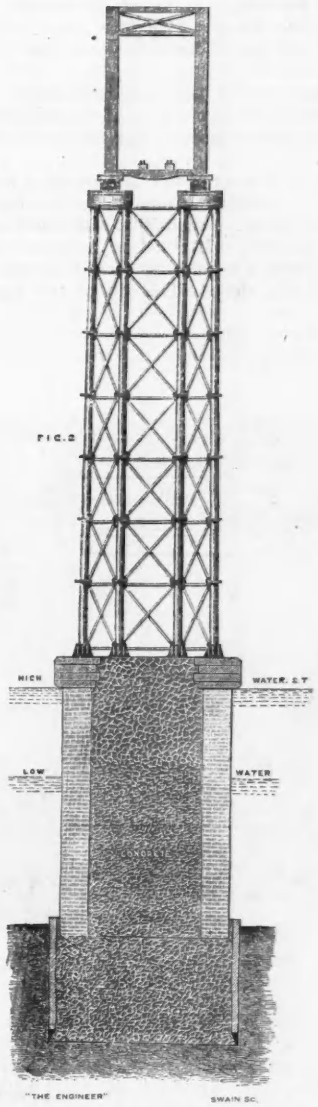
It would to-day serve no useful purpose, even if it were possible, to describe the Tay bridge, as finally constructed, in detail. The disaster affected one particular part alone of the structure, and to that part only need we give any close attention. As a general picture it may be said that the bridge was 3450 yards long and ran almost due north and south across the estuary of the Tay from the south, or Fifeshire, shore, until, just before reaching the Dundee side, it curved eastwards. The single line of track was carried across eighty-five spans. With one exception—a bowstring girder near the Dundee end—all the spans consisted of lattice girders. Their lengths varied over a wide range, from 29ft. to 245ft. The girders were continuous over the piers in groups of four or five. For the most part the rails were supported on the top booms of the girders. Near the centre of the bridge, however, there were thirteen spans—eleven 245ft. and two 227ft. long—across which the rails were supported on the lower booms. These central girders were about 27ft. deep and weighed about 190 tons each. As originally designed, the bridge was to have had fourteen central spans, each of 200ft., but in order to hasten its construction the thirteen longer spans were substituted. It was these thirteen spans, alone and all of them, that collapsed.



SECTIONS AND DETAILS OF PIERS AND COLUMNS OF COLLAPSED SPANS

Technically the bridge was really a series of bridges, of different design and construction, linked together. In no respect was its heterogeneous character more apparent than in its piers. According to the original plan the piers were each to have consisted of two iron cylinders lined with brick set in cement. A number of such piers were actually built, but the construction of the rest was varied very considerably. There were, in fact, at least five different patterns of pier in the finished structure. Some were entirely of brick in cement, others were composed of cast iron columns and others again of cast iron cylinders filled with concrete. The piers of the collapsed spans were each founded on a cylinder 31ft. in diameter sunk into the bed of the river and filled with concrete. On this foundation there was erected a hollow six-sided brickwork structure measuring about 27ft. from cut-water to cut-water and about 16ft. in width. The brickwork extended to high-water level and was finished with four 16in. courses of stone coping. The brickwork of the piers, up to a height a little above low-water level, was erected on land, floated out between barges and dropped into position on the foundations. When the remaining brickwork and the stone coping had been added the interior of the whole was filled with concrete.

On top of the stone coping six cast iron columns were erected. Each column consisted of a series of six pipes united at their flanges by means of eight $1\frac{1}{8}$in. bolts. The six columns were tied together by double wrought iron channels disposed horizontally at the level of each flanged junction and were diagonally braced by flat wrought iron ties. Those channels and ties were bolted to lugs cast on the sides of the column sections. At their lower ends the columns rested on cast iron base plates secured by four holding-down bolts to the stone coping. These holding-down bolts had slightly tapered heads and were simply cemented



PIER AND COLUMN OF COLLAPSED SPAN

into holes drilled in the two upper courses of the stone coping. At their upper ends the six columns of each pier were united into two groups of three each by wrought iron entablatures on which cast iron bearing plates were mounted. Between these bearing plates and similar plates on the underside of the lattice girders rollers were placed. At three of the piers the rollers were omitted and the lattice girders were bolted to the entablatures. The interiors of the columns were filled with concrete.

The total length of the girders forming the thirteen spans which collapsed was 3149ft. As has already been stated, the girders were continuous over four or five spans. The collapsed portion was formed of three continuous lengths, the southern, 1225ft. in length, covering five spans; the middle, 944ft. long, covering four spans; and the northern, covering four spans. Of the thirteen spans, the first and second counting from the southern end were on a rising gradient. Then followed six spans on the level. The remaining five were on a falling gradient. At the highest point the distance from the top of the piers to the underside of the girders measured 83ft. Over the fallen portion of the bridge and for a considerable length on each side of it the course of the rails was a continuous straight line.

(To be continued)

La Tuque Hydro-Electric Development

No. II

(Continued from page 4, July 4th)

Description of Development

THE dam is 1337ft. long from end to end. It consists in general of the west bulkhead and corewall, the sluice section, the intake section, and power-house, and the east bulkhead. All sections of the dam are gravity type concrete structures and were designed for the following conditions:—

(1) Horizontal pressure on the upstream face due to water in the forebay at El. 498.

(2) Horizontal pressure due to ice, assumed to be 10,000 lb. per lineal foot applied at El. 497.

(3) Uplift on the base of the dam over the whole area, assumed to be the full head at the upstream face and decreasing uniformly to zero or to tail-race pressure, if any, at the toe.

(4) The weight of concrete was taken at 150 lb. per cubic foot.

(5) The assumed uplift on the intake section was modified to two-thirds of the above and a more extensive drainage system was provided under the base.

The sluice section of the dam contains five main sluices, two regulating sluices, and a log sluice. The main sluices are each 50ft. wide and have their sills at El. 467, 31ft. below normal head-race level. The two regulating sluices are each 21ft. wide by 21ft. deep. The sill of the log sluice is at El. 492 and it has a width of 26ft. All of the sluiceways are provided with motor-operated, fixed-roller steel gates. The discharge capacity of the sluiceways is 170,000 cubic feet per second with forebay at El. 498 and more than 200,000 cubic feet per second when the water is at El. 500.

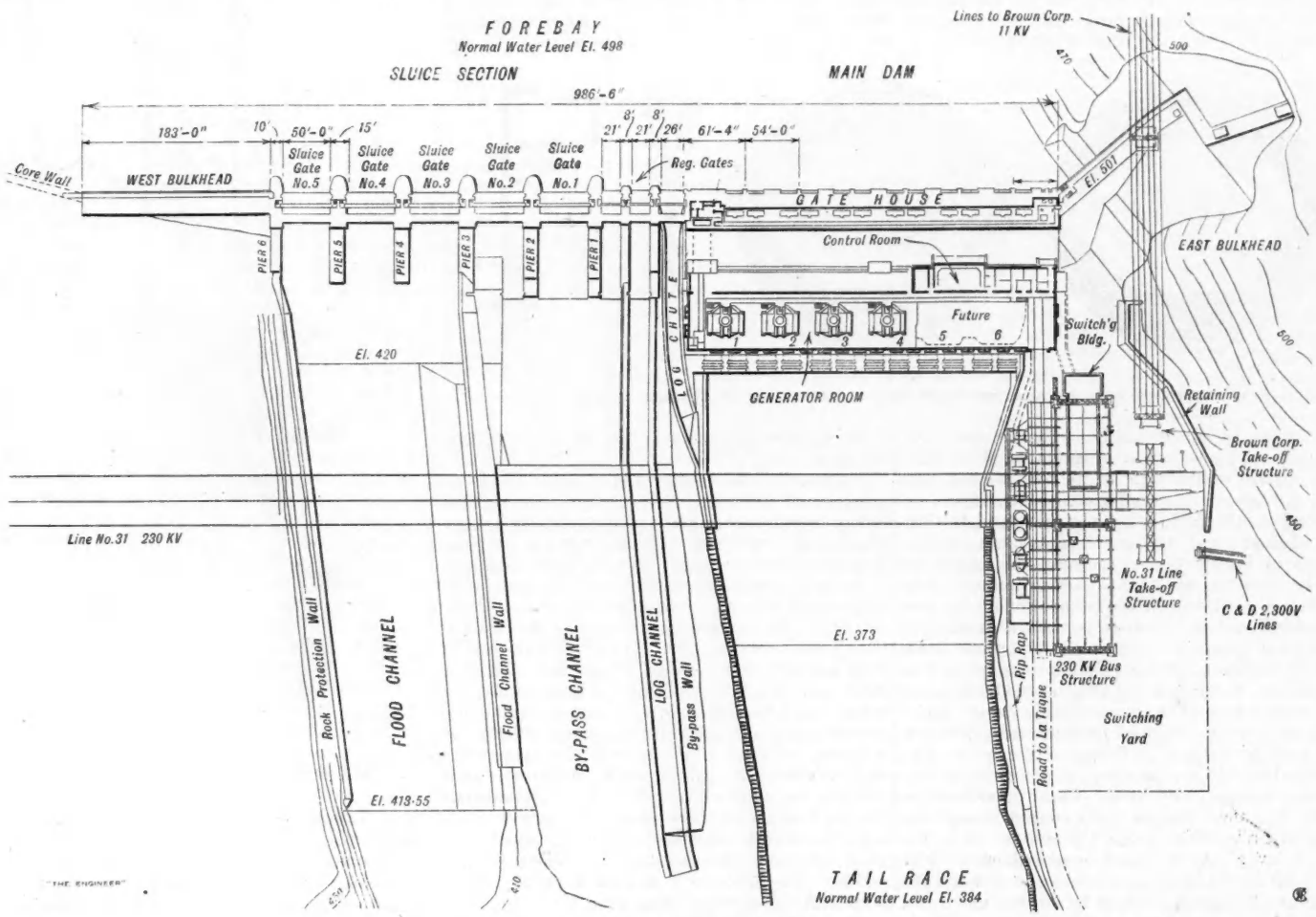
The intakes for six turbines have been provided, each intake consisting of two water passages 15ft. wide, connected to a 22ft. steel penstock. The penstocks are completely embedded in the concrete. The intakes are closed by means of steel head gates with fixed rollers, the head gates being operated through line shafting by two motor reduction units. By means of jaw clutches, either of the motor reduction units can raise any one of the head gates. The lowering and raising of the gates is actuated by push buttons in the gate house, with lowering buttons also in the control room of the power-house. A 36-ton gantry on the top of the intake section has been provided to lift the gates out of their slots for painting and other maintenance, and also for handling the racks and emergency gates which are installed in slots on the upstream face of the dam.

Four hydro-electric units are installed in the power-house, with settings for two additional units for future installation. At 114ft. head each unit has a rated capacity of 44,500 H.P. at point of maximum efficiency and is capable of delivering 48,000 H.P. at full gate. The turbines are connected to 11,000-volt, 60-cycle generators rated at 40,000 kVA at 90 per cent. power factor. The generators are fully enclosed and water cooled. Louvres are provided in the housing for the purpose of heating the power-house in cold weather. With the louvres closed the air is circulated through cooling coils supplied with water from the forebay. Enclosing the generators is a new departure for the company. It was done principally for the purpose of reducing the accumulation of dust in the air passage around the generator windings and of maintaining the coils at a fairly uniform temperature at varying loads, but it has the added advantage of reducing both noise and heat in the power-house.

The generator leads are carried through a tunnel to the switch building, which is situated a short distance from the power-house, and connected to an 11,000-volt bus which is segregated into four sections. The bus sections are connected, through air-blast circuit breakers, to the Brown Corporation's 11,000-volt transmission line, and to the Shawinigan Company's transformers, which step the voltage up to 230,000 volts for transmission to the terminal station at Three Rivers. Three transformers are at present in service, two rated at 36,000 kVA and one at 40,000 kVA is in course of manufacture. The generators and transformers are connected in parallel on the high-voltage bus only, through motor-operated disconnecting switches. Provision has been made for the future installation of a high-voltage circuit breaker for the line, which at present is directly connected to the high-voltage bus.

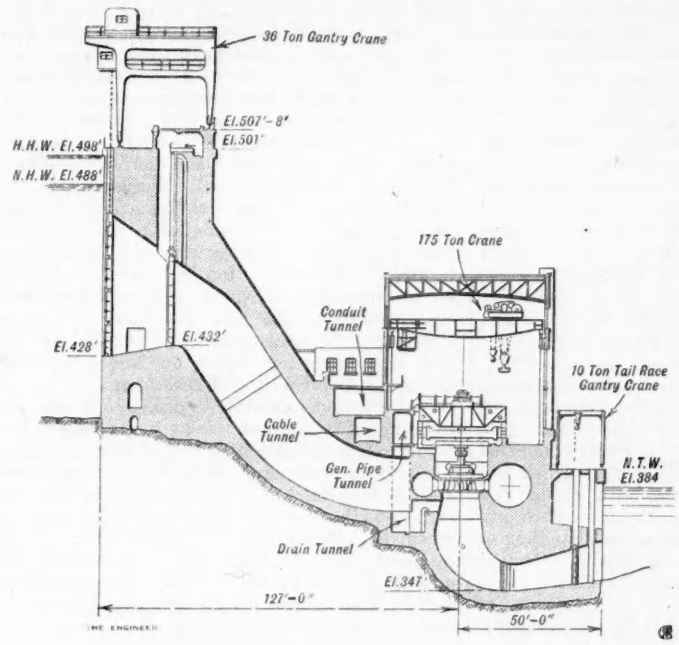
The bedrock at the dam site consists of a granite gneiss, the foliation, or apparent bedding, of which varies considerably over different parts of the foundation. In the vicinity of the west bulkhead and the sluice section, the foliation strikes diagonally across the line of the dam and dips toward the north-east at an angle of about 20 deg., while under the intake section the strike is transverse to the dam and the dip at a slight angle to the east. A fault near the western end of the intake section divides the two areas of two different geologic structures. The strike of this fault is almost normal to the axis of the dam, and it dips toward the east at an angle of 48 deg. It showed upon the surface as a small gorge, about 10ft. deep, that had been eroded in the bed of the river. Near it two parallel faults were encountered, one to the east and the other to the west.

The most important feature of the geologic



PLAN OF LA TUQUE DEVELOPMENT

structure in relation to the dam is a fault zone under the east bulkhead. The fault planes in the river are nearly parallel to this zone and are related to it. The footwall was encountered about 50ft. east of the end of the intake section dipping toward the east at an angle of about 47 deg. to the horizontal. The hanging wall intersects the face of the cliff at about El. 470, 30ft. below the top of the dam. The faulted zone, 200ft. wide, that lay between was composed of thick strata of hard, grey rock alternating with strata of badly fractured red rock, some parts of which



SECTION THROUGH DAM AND POWER-HOUSE

near the surface were so decomposed that they could be dug by a power shovel. In order to obtain rock sufficiently sound for the foundation of the east bulkhead it was necessary to carry the excavation down along the footwall of the fault to below El. 380. At the inner end of the cut its depth was more than 80ft. below the surface. Excavation for a cut-off wall along the upstream face of the structure was continued to a further depth of about 50ft.

As a precaution against seepage of water along the horizontal joints underneath the dam a programme of grouting the foundation was followed. Diamond drill holes were put down along the whole upstream face of the dam at intervals of about 30ft., except at the east bulkhead, where more extensive grouting was done. Along the intake section of the dam these holes were drilled to a depth of 100ft.; at the sluice section and west bulkhead the depth was 50ft. Many of the holes were tested for tightness with water at a pressure of 90 lb. per square inch, and all were grouted to refusal at pressures varying from 90 lb. to 50 lb. per square inch, depending upon the depth at which the grouting was done. Where any evidence of open joints was found sufficient additional holes were drilled and grouted to assure the complete sealing of the foundation.

Although the stratum of rock which was finally reached in the excavation for the east bulkhead and on which the structure was built was sound, it was badly broken by the faulting and it was considered advisable to consolidate it by grouting. Holes were drilled to a depth of 20ft. on 5ft. centres each way over the whole surface and grouted at a pressure of 90 lb. per square inch. In addition to this, in order to eliminate the possibility of percolation beneath the structure, a row of diamond drill holes on 5ft. centres, parallel to the upstream face, was put down into the foot wall and grouted at a pressure of 200 lb. per square inch. The deepest of these holes, near the face of the cliff, penetrated the foot wall at about El. 270. The inspection tunnel in the east bulkhead is built with sufficient headroom to permit additional drilling and grouting if evidences of undue percolation should be discovered in the future.

The excavation and preparation of the foundation for the east bulkhead would not have been such a serious matter had it not been for rock falls that began to occur from the face of the cliff after the work had progressed well into the cut. The cliff had been carefully scaled and appeared to be perfectly safe, but it is probable that the heavy blasting that had been carried on over the rest of the job for a period of almost two years had loosened some of the joints. The first warning came with a fall of a mass of rock from a point about 100ft. up that almost buried a shovel working in the cut. Various scaling operations were tried in an effort to remove the hazard from this source, but finally the whole face of the cliff, from top to bottom, had to be sliced off to a depth of about 10ft., removing 15,000 cubic yards of solid rock in the process before it was considered safe enough to resume work.

The east bulkhead, like the rest of the dam, is built in sections about 50ft. long. The most westerly section rests on undisturbed rock. The fractured rock under the other sections is progressively deeper toward the east end, owing to the slope at the foot wall of the fault. For this reason the company's geologist, Mr. Irving B. Crosby, M.E.I.C., in view of the possibility of unequal settlement between the sections, recommended that some form of seal should be provided in the vertical construction joints to prevent seepage through the joints should such settlement occur. After giving the matter some consideration it was decided that the type of seal provided in the other vertical joints throughout the dam would be adequate for this purpose. These seals were adapted from those used in the Chonchas dam in New Mexico, where the possibility of unequal settlement was anticipated, and were constructed as follows :—

(1) A 6in. diameter vertical hole was formed in the concrete, centred on the joint and 6ft. back from the upstream face of the dam.

(2) Twenty-ounce copper sheets were formed around the upstream semi-circumference of the hole and projected into the concrete on each side a distance of 12in. The horizontal joints of the sheets were soldered together and the vertical edges were reinforced with two 1in. by ¼in. steel bars.

(3) The hole was filled with a plastic asphalt compound that retains its plasticity at relatively low temperatures. Numerous tests were made on various plastic materials until one was found that filled the various requirements.

To uncover the bedrock at the site of the sluice section and the west bulkhead and along the discharge channels it was necessary to excavate 230,000 cubic yards of overburden. This material was stripped by power shovels and trucked to spoil banks on the hillside a short distance downstream. Owing to the great depth of the overburden at the end of the west bulkhead the excavation for the corewall, which projects beyond the bulkhead a distance of 90ft., was made by tunnelling. The tunnel was driven along the gradually rising rock to the point where the rock surface was about 4ft. above normal head-race level. The foundation of the corewall was prepared by barring off any loose rock encountered. The concrete was poured against the sides of the tunnel cut by removing the sheathing just ahead of the pouring, care being taken to fill with concrete any caves that had occurred in the tunnel walls. The corewall was brought up to the level of the top of the dam and the upper part of the tunnel was backfilled.

CONSTRUCTION

The construction of La Tuque development was begun in March, 1938, with the clearing of the site of the construction plant and the erection of some of the construction buildings. One of the first operations was the building of No. 1 cofferdam for the unwatering of the diversion channel on the west side of the river. The swift current in the deep channel near the west bank presented a problem, in that it was necessary to construct the first cofferdam across this channel. The first crib of the cofferdam was situated in a comparatively quiet eddy formed by a point of rock that projected into the river a few hundred feet upstream from the line of the dam. This crib served as an anchor for the rest of the cofferdam and from it the cofferdam was built diagonally downstream across the deep channel, gradually crowding the current to the other side of the river bed. The east end of this part of the cofferdam rested on a ridge of rock, some points of which projected above the water to form small rocky islands. From these islands the cofferdam was continued downstream

INTERIOR OF POWER-HOUSE

VIEW OF CONSTRUCTION PLANT

parallel to the shore to the lower end of the by-pass channel, a distance of about 800ft.

The control works of the by-pass channel consisted of four water passages through the lower part of a portion of the sluice section. One of these passages had a clear width of 50ft. and the other three were each 21ft. wide. The rock excavated from the by-pass channel was crushed by two 16in. gyratory crushers set up temporarily on the west bank and transported across the river to the mixer plant on a belt conveyor carried by a light steel truss bridge consisting of three 115ft. spans supported on timber crib piers. In addition to the conveyor, the bridge carried a walkway. Concrete for the control works was brought across the river on the same conveyor, transported to the structure in 2-yard bottom-dump buckets on cars drawn by gasoline locomotives and handled into place by derricks. In order to prevent scour in the by-pass channel the bottom is paved with concrete for a distance of 600ft. below the dam. Upon completion of the control works the upstream section of No. 1 cofferdam was blown up and the water diverted through the by-pass channel by the construction of cofferdam No. 2.

The construction programme was based on a period of two years and nine months, beginning in March, 1938, with completion of the project by December 31st, 1940. In order to direct and control the work a comprehensive schedule was prepared at the beginning, showing the amount of work to be done, with the starting and completion dates for each item. Construction of the development may be divided into three main sections or periods, each representing a definite phase.

The primary phase includes all work from the beginning of construction to the diversion of the river through the by-pass channel in November, 1938. During this period the site was cleared, the railway siding completed, the permanent and temporary roads and bridges finished and the construction of all the temporary buildings, as well as provision for water supply, fire protection, communication power supply and distribution completed. To complete the installation of derricks and shovels and the rock crushing and concrete mixing plants with their conveying systems, storage piles and bulk cement handling facilities in time to meet the excavating schedule of July 15th and the pouring of concrete on September 1st was a difficult and strenuous task, but was successfully accomplished. Other work completed in the initial stage of construction was the stripping and opening of the sand pit, the installation of adequate facilities for the handling and transportation of all material from the railway siding to the job, the building of wharves and scows for the transporting of construction plant and other necessary material to the west bank of the river, the construction of the light steel bridge with conveying system for the handling of rock from the temporary crushing plant on the west bank to the rock storage pile near the mixer plant and for the transportation of concrete to the diversion channel structures as well as numerous miscellaneous details to make this portion of the installation a well-integrated lay-out.

The concrete, as has been mentioned before, was transported from the mixer plant by a belt conveyor to hoppers situated at various points along the line of the dam. From the hoppers it was handled by derricks to the point of deposit in the forms in 2-yard bottom-dump buckets. The concrete was placed very dry and compacted by vibrators. The firm's experience with vibrators was not an entirely happy one. This was not due to any fault of the vibrators themselves, but to the ease with which the foremen found they could move the concrete from one part of the form to another and their tendency on this account to have the concrete deposited at one point, possibly more easy of access than others in the form, and to use the vibrators to make it flow to the corners and other less accessible places.

The crusher plant contained a 42in. by 48in. jaw crusher and two 16in. gyratories. The first cut to be made after completion of the power-house cofferdam was the excavation for the draught tubes. This cut was more than 40ft. deep. The rock was mucked by power shovels into skip boxes and hoisted by derricks to side-dump cars on a trestle along the downstream side of the cut. The cars were drawn by gasoline locomotives to the crusher plant, where the rock was reduced to a maximum size of 4in. At the crusher plant it was screened and then carried to and distributed along the storage pile by belt conveyors. From the storage pile the rock was taken by belt conveyor, operating in a tunnel underneath the pile, to bins at the top of the mixer plant. Upon completion of the draught tube cut the excavating equipment was moved to the tail race and to the west bank, these two parts of the job being carried on simultaneously. The tail-race excavation was begun about 750ft. below the power-house and carried level at El. 350. From the tail-race cut the rock was transported by trucks to the crusher plant or to a spoil bank a short distance downstream.

The compressor plant had an installed capacity of 2300 cubic feet of free air per minute when operating against a pressure of 100 lb. per square inch. The two larger units (1040 cubic feet per minute each) were of the horizontal reciprocating type, two-stage compression with inter-coolers and after-coolers. Each unit was direct connected to a 200 H.P. synchronous motor. The small compressor was of the rotary type (220 cubic feet per minute) direct connected to a 50 H.P. S.C. motor. The installation was complete with control equipment, intake filters and air receivers.

Owing to the proximity of the job to the town of La Tuque it was not necessary to build camps for the men except at the peak of the work, when additional accommodation had to be provided for about 200. During the thirty months when the work was in full swing La Tuque was a boom town, as in that period more than 2,000,000 dollars was paid out in wages, most of which was spent in the town.

La Tuque is on the National Transcontinental Division of the Canadian National Railways. A siding from this line was built to serve the job, about 1¼ miles from the dam site and connected with the construction yard by a road which was surfaced for a width of 20ft. with a hot mix asphaltic concrete pavement. Facilities were provided at the siding for unloading and handling of construction materials and equipment. Cement came to the siding in bulk and was unloaded by a conveyor into two steel silos with a capacity of 350 tons. From the silos it was drawn to the job as needed in special tank body semi-trailers. More than 1200 car loads of miscellaneous materials and 1400 car loads of cement were received at the siding during the course of the job.

The construction of cofferdams in 1938, designated as auxiliary work, amounted to 35,000 cubic yards, or to 70 per cent. of the total built. The only permanent work done prior to the passing of water through the by-pass during the primary phase was removal of 125,000 cubic yards of excavation and the pouring of 39,800 cubic yards of concrete, equivalent to 18 per cent. and 14·7 per cent. respectively of the total quantities involved. The diversion of the river from its regular course into the by-pass channel on the scheduled date of November 29th by the removal of a cofferdam in one blast completed the initial phase of the work.

The secondary phase involved the substantial completion of excavation and mass concrete work and the closing in of the power-house superstructures ready for the installation of equipment by the end of November, 1939. This period is usually regarded as one of "operation," and, outside of the uncertainty of unwatering and the danger of flooding, causes no particular worry. It is the phase of mass production when various units of construction plant have an opportunity to demonstrate their efficiency and adequacy as an operating unit. The volume of excavation removed in this period amounted to 500,000 cubic yards, or 70 per cent. of the total. The pouring of concrete could not be started until June 15th, when unwatering of the main river sections following spring flood was completed. In the following five months 150,000 cubic yards, or more than 55 per cent. of the total concrete of 270,000 cubic yards, was poured, an average rate of 1200 cubic yards per day. The scheduling and control of this portion of the work was comparatively simple, as the plant installed during the early stages of the job was designed for a given purpose, and no difficulty was experienced in keeping the work up to schedule, with the single exception of the east bulkhead, where extensive faulting increased the volume and difficulty of excavating the foundation considerably and doubled the quantity of concrete. This forced the work into the first quarter of 1940.

The final stage consisted of installing the hydraulic, electrical, and auxiliary equipment closing the by-pass channel and raising the water to normal operating level, the pouring of final concrete and the finishing of a host of details to properly complete the job.

The various schedule dates were maintained with the exception of the by-pass closure, which could not be started until after the 1940 spring flood had dropped off to 25,000 cubic feet per second. While this date was based on an average of a thirteen-year record of river flow plus ten days for contingency, the flood was late in starting and of longer duration than previously experienced. Immediately after the spring flood, the closure of the 50ft. opening in the control works of the by-pass channel was made by means of sluice gate stop logs. Some doubt was expressed as to whether the stop logs would go down of their weight through the swift current that was flowing through the openings to a depth of 15ft. Several years before, when one of the sluice gates at La Gabelle got stuck in the open position, it had been found necessary to close the 50ft. opening with similar stop logs, and no difficulty was experienced. Recently published results of tests on models showed that, under the conditions at La Tuque, the stop logs would not go down without assistance, and accordingly pile hammers were provided at each end to force them down if necessary. The hammers were not used. The closure of the other three openings was made by means of special fixed roller gates, which were left in place after the concreting of the openings was completed. The closure was delayed by ten days, and as a result the turning over of No. 1 unit was nine days behind schedule. The remaining three units went "on the line" slightly ahead of schedule, with the final unit producing power on November 26th against a scheduled date of December 1st.

The detailed schedule worked out at the beginning of the project was an indispensable tool in controlling and directing the work at all times. It was followed in detail for specifying the delivery of all material and equipment, and gave constant warning to the drawing-office of the dates on which drawings would be required in the field. One of the most valuable uses was in estimating the monthly expenditure in advance of requirements in order that suitable arrangements could be made for financing.

Associated with the Shawinigan Engineering Company on the work were Mr. Hardy S. Ferguson, M.E.I.C., consulting engineer; Mr. Irving B. Crosby, M.E.I.C., consulting geologist; and Mr. J. Cecil McDougall, M.E.I.C., architect.

X-Raying Circumferential Seams*

By ROBERT C. WOODS, Physicist, Bell Aircraft Corp., Buffalo, N.Y.

IN the radiography of welded circumferential seams in cylindrical vessels and tubes, various methods are now in use to ensure the correct placement of X-ray films relative to the source of radiation. Although it may find other applications, an instrument devised by the author is excellent for the following conditions:—In Fig. 1, B is a circumferential weld in tank, X is the X-ray tube target located so that a line from X to the tank centre O is parallel to ground. F is a film holder or cassette.

From the diagram it is quite evident that line X L

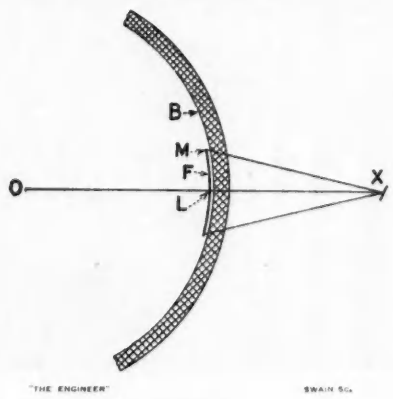


FIG. 1

is shorter than X M. Since X-rays, like other electromagnetic disturbances, decrease as the square of the distance from their source, it follows that the radiation intensity at M will be less than at L and, as a result, film F will receive less exposure at M. Moreover, due to the angle at which it traverses the weld at M, the X-ray beam will have a greater quantity of metal to penetrate at that point than on line X O, thus still further reducing its intensity.

For these reasons production of a good radiograph under such circumstances requires the centre of the film to be placed at L.

In considering this problem it must be kept in mind that pressure vessels and similar structures

*_The Iron Age_, April 10th, 1941.

afford little or no outside view to any worker inside, and handy reference points for measurement are often few and far between. At present one method for effecting good film placement is to mark off film lengths on the inside wall, starting at some given point—for example, a longitudinal seam. From the exterior side of the same seam the outside circumference must then be marked off, sufficient overlap being allowed to compensate for the variation between inside and outside circumferences. While this system is fairly rapid, it has the disadvantage of a progressive inaccuracy, because each time the tank is rotated to bring a fresh, unexamined length of weld into the X-ray view it is rarely turned through an identical angle. This is especially true if the turning is done by motor, since whatever error in braking occurs is bound to be cumulative. If the turning is done by human power the results will be very unpredictable.

Therefore, even if the mark and turn method is accurate at the start, so many variables are involved during the X-ray of a complete weld they make some sort of intermittent check very desirable.

Referring to Fig. 2, A is a combination spirit level fitted with protractor, such as is commonly sold by machine tool supply houses. This device is fastened to a rigid metal or wood base, which in turn

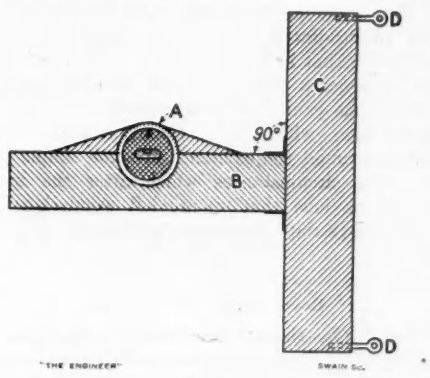


FIG. 2

is joined at exact right angles to another rectangular support C. It has been found most convenient to make C out of wood so that the shafts of the small rubber tyre castors or wheels D D can be made extensible to care for various arcs.

This instrument can be placed against the outside of the weld and lined up to show the declination from horizontal, if any, of the line X O which represents the shortest X-ray path from the target X to the tank wall.

After a reading has been taken to determine elevation—a quantity which will remain constant over the entire weld—the instrument may be taken inside the tank, protractor set at the proper division on the scale, and the first film position marked off. This makes tedious reference point measurements unnecessary right from the start. Thereafter the device can be used to set each film or only when a check seems advisable, depending upon the preference of the radiographer.

The dimensions of the instrument itself may vary and depend to some extent on the size of level protractor available. A convenient size for use in vessels with diameters of 4ft. or over is such that C is 12in. by 2·5in. and B 9in. by 2in. With this device it has been found possible to locate points with an accuracy of 0·5 deg., even taking into account the fact that some of the measurements made by eye cannot be absolutely precise.

South African Engineering Notes

(By our South African Correspondent)

CAPE TOWN, May 26th.

Union Railways, 1940-41

DURING the financial year ended March 31st, 1941, the upward trend of traffic which was manifesting itself in 1939 suffered a slight recession on the outbreak of war, but this was only of a temporary nature and the year 1940 was notable for the extremely heavy volume of traffic offering and handled. With the export of iron ore, a new industry has been opened up in this country, and it is expected that the commitments for this mineral will be heavy for the duration of the war. The annual shipments already run over 60,000 tons. Manganese ore shipments, which had fallen to a low figure, are now as much as 35,000 tons per month. Motor vehicle despatches from the assembly plants at Port Elizabeth in the latter half of 1940 assumed unprecedented proportions. During this period 21,286 short trucks were despatched, as compared with 10,119 for the corresponding six months in 1939 in respect of this traffic. The volume of passenger traffic was another feature of the year's working. Military traffic has had a distinct influence on railway returns. In addition to large troop and war material train movements, soldiers on leave have been catered for. During the year, 1027 special trains were run to meet the requirements of the Defence Department. The introduction of new services and extension of existing services during the year increased the route mileage of the railways' road motor services by 994, making the total under this head 16,819 miles. There was, however, a loss of £42,000 in this revenue for the year, mainly due to the withdrawal of the subsidy of 8½ per cent. from railway revenue to road motor service revenue, plus increased cost of petrol, oils, and spares.

Cape Town Docks

At the Cape Town docks the main development at the New Basin is proceeding steadily, though it is doubtful if all will be completed by the end of the year. The new deep-water berths, A, B, C, and D, which the elbow forming one side of the entrance to the Basin and the whole of the quayage on the north side of the Basin contains, are completed, and the quay wall forming the foreshore side of the dock and which will, when completed, provide the quayage for the deep-water berths E, F, G, and H, has been completed to a length of 3031ft., while foundations have been laid over a distance of 3400ft. out of the 4000ft. required. When it becomes necessary to meet the demands of shipping the quay can be extended to over 6000ft. in all, while still further berthing accommodation can be provided, when required, by the quay which will run from the end of the foreshore quay to the mole, which constitutes, for the present, the seaward side of the dock. It is on the Woodstock side of this connecting quay that the projected new graving dock will be constructed when the Union Government can be persuaded to proceed with it. A step forward has been recently taken for this, the Government having invited the contractors for the present works to state if they would be prepared to tender for the work.

National Roads Five-year Plan

Colonel P. I. Hoogenhout, Chairman of the National Roads Board, stated in an address at the end of April that the National Roads Five-year Plan had already taken seven years, and would probably take another five. He said that the estimated expenditure for the original five-year plan was £22,000,000, but he thought it would involve about £30,000,000. Already 2206 miles of the 5400 miles recommended to be done had been completed. Britain and America, he said, were looking at us with envious eyes, for if they had to broaden their roads as the National Roads Board were doing, they would have to buy up large blocks of property at prohibitive prices. The Board had already constructed 237 bridges and 122 were being built. Of the roads completed, 1100 miles had been asphalted.

He went on to outline the policy of the Board in laying down roads. The areas were selected after consideration had been given to the density of the population, the volume of traffic, and such-like factors. Their objective was to provide all-weather roads, free from dangerous curves and, where possible, to follow a direct route. In trying to carry out this policy, the Board had been involved in some nasty scenes with local bodies, who all maintained that the national road should pass through the centre of their towns. For the road between Paarl and Kraaifontein, the Board would expropriate a width of 150ft., and from Kraailfontein to Cape Town 220ft. This would allow a cycle lane and sections for fast and slow traffic. When it is finished it will compare favourably with any road in any part of the world. The expropriated area will be reserved, even if the Board does not use all of it. The time will arrive when Cape Town will have to buy up whole blocks of buildings to obtain the required width of roads. This is now happening in America. No building will be allowed nearer than 100 yards from the Union national roads, except near towns, where ground is more valuable.

New Motor Vehicles

New motor vehicles registered during March showed a large increase. There were 2968 new cars, 504 new motor buses, lorries, trucks, and vans, and 33 new motor cycles; 2828 of the cars came from America, 131 from the United Kingdom, and 14 from other countries. Of the motor buses, lorries, &c., 488 were from America and 16 from other countries. Two motor cycles were from America, 29 from the United Kingdom, and two from other countries.

Cape Town's Dry Dock Campaign

Cape Town townspeople, with import and export firms, shipowners, and mercantile captains are maintaining a strong campaign, having for its object the persuading of the Railways and Harbours Administration to proceed with the construction of a large dry dock, which is included in the present large scheme of dock extension, but which the Administration argues is not urgently needed. Early this month the Minister of Railways and Harbours, Mr. F. C. Sturrock, told a deputation representing all public and commercial bodies interested in the development of the harbour, that, although he agreed that a dock would ultimately be required, there were more pressing calls upon money at present, and he could not promise when the dock would be sanctioned. As advised by the Minister, the Harbour Advisory Board will continue its investigations into the size and type of dock required, and when in consultation with the other interested bodies it has a cut-and-dried proposition to put forward, it will again approach the Minister. All the necessary data are not yet available to enable a decision to be made. The point that the advocates of the dry dock are trying to make is that the money which the Administration will receive from the sale of reclaimed land will more than pay the expense of the present development scheme, including the dry dock. The Harbour Board is at present investigating the merits of a number of alternative schemes. It is generally agreed that a dock, 1250ft. long, able to take the biggest ships, is desirable, and that it should be divided into two or three compartments, and so designed that it could be used as a wet dock when not required for dry-docking. If it is not practicable to construct the big dock, which would cost something over £1,000,000, it has been suggested that the first 850ft. or so should be built now in the form of a complete dock, and the extension could be made when convenient.

Extensions to Iscor

The Union Parliament has just authorised an increase in the borrowing powers of "Iscor," the State-controlled South African Iron and Steel Industrial Corporation, with its works at Pretoria. The Minister of Commerce and Industry, in moving the increase, said that the Bill authorised Iscor to increase its borrowing powers from £1,000,000 to £3,000,000, and said this had been rendered necessary because of the considerable installation extensions which would take place at Pretoria and later at Vereeniging. Iscor proposed to instal a third blast-furnace, a complete new mill, and a complete wire-making plant for the production of about 40,000 tons of fencing wire annually. It was proposed ultimately to increase Iscor's steel output to between 600,000 and 650,000 ingot tons per annum. Even then South Africa would still produce only about two-thirds of its requirements per annum, and the coast areas would still have to import their steel from overseas.

Before anything like an output of 600,000 tons of ingots was reached, however, it would be necessary to increase the capital of the Corporation, and it was hoped to introduce a Bill next season to increase that capital considerably, and probably to increase the Corporation's debentures. The country could feel gratified that Iscor had come to its help during the difficult period of the war. Apart from its steel output, Iscor had helped to produce even more valuable items.

New Post Office at Cape Town

The erection of Cape Town's new post office is now nearing completion. It is certainly a noble pile. The materials used in making the new building are as staggering as the size of the new building itself. They include 3,500,000 bricks, 100,000 bags of cement, 55,000 cubic feet of Parys and Paarl granite, 47,000 cubic feet of reconstructed stone, 11,000 cubic yards of concrete, 5060 tons of constructional steel, 4090 tons of steel reinforcement. Most of this material was delivered, fabricated or mixed, and placed in position in record time. An amazing achievement considering that the Union is at war and times are difficult.

Making Paper in the Union

The S.A. Pulp and Paper Industries shows a net profit for its first complete year's operations of £10,500, after providing £40,000 for depreciation. This compares with a loss of £85,003 in the nine months of operation in 1939. Last year 10,000 tons of paper were sold, compared with 4000 tons in 1939. The trading profit for the first four months of this year are substantially above the average of last year. This new and highly specialised enterprise has successfully overcome all technical difficulties, and its technicians are concentrating on securing more constant standards of finish and greater output from the paper machines.

"NOMINATED LOADING."—This is the term applied by the Railway Executive Committee to a system introduced in order to speed up the transport of small consignments of goods train traffic which cannot be forwarded in through wagon loads. It plans the arrangement of regular services of through wagons to certain destinations on specified days of the week. This system was operated in the last war with beneficial results, and the railways' announcement that, as from a date in June, it will be adopted to improve transit will be generally welcomed. Consignments of miscellaneous general merchandise of less than 1 ton will only be accepted on specified days of the week, or by the route of one railway, for conveyance to certain destinations or areas. The railways will advise traders of the destinations and the days of the week upon which such traffic will be accepted and the name of the railway to whom the goods must be tendered; in no case will the nominated days for despatch be less than two per week. Traffic between important towns will not be affected by the system.

The Engineer

JULY 11, 1941

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CHANGES OF ADDRESS

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HISTORIC DISASTERS

THE peripatetic series of articles on historic disasters which we begin in this issue is designed, not merely to recall the tragic particulars of some notable mishaps, but also to emphasise the lessons which were learned and which still can be learned from them. These lessons are human as well as technical. Rarely, if ever, is it the case that a disaster can be assigned solely to the failure of materials or the disruptive strength of natural forces. Always, or nearly always, persons and personalities play a part—frequently a preponderating part—in the contributory causes. It is usually difficult to separate the two aspects and, in our view, it is scarcely ever desirable to attempt the separation. Take the Tay bridge disaster, for example. A purely technical account of that lamentable event, one dealing solely with the natural forces involved and the strength and quality of the materials provided to withstand them, would be unsatisfying and incomplete and would rob the narrative of some of its most important lessons. It is not sufficient to say that on the night of December 28th, 1879, the wind reached gale force in the estuary of the Tay, that the turning moment exerted on the thirteen central spans of Bouch's structure was as a consequence so much, while their resistance to overturning was something else. The disaster might be explained in that manner, but while physics would support our account of it, our knowledge of human nature would call out for further explanation. A satisfying answer to the demand to know why the bridge collapsed inevitably takes us beyond the region of natural forces and inanimate materials. The bridge was conceived by human minds and built by human hands and the real cause of its failure resided in the defective operation of those minds and the defective execution of those hands. We must probe—and probe deeply—into the human background of the disaster before its cause really becomes clear. When we do so we find that wind pressures, turning moments and the resistance of materials played almost a secondary part in the disaster. Its real cause lay in the incompetence and carelessness displayed in the design and construction of the bridge, in the bad workmanship exhibited in the production of certain vital parts, in defective supervision over the fabrication and erection of the members of the structure and in defective inspection of the bridge after it was erected.

So, too, is the story of the loss of H.M.S. "Captain," which will follow shortly in the series; the technical aspects of that disaster might be compressed into a paragraph, but they would not satisfy our desire to be informed as to its true cause. A few data, a few calculations and one or two curves would suffice to show that the "Captain" when she put to sea on her third and last voyage on August 4th, 1870, was inherently unstable to a dangerous degree and that when she capsized a month or so later she but met the doom which might have been foretold for her. Naturally, we ask, why was her unseaworthy condition not recognised in time to avoid the disaster? Going more deeply into her story we are compelled to ask why was the "Captain" ever allowed to be built and how did it come about that the Admiralty, against the clear advice of its Chief Constructor, allowed the ship fully manned to put to sea? Clearly these questions are such that they cannot be answered without delving deeply into the personal, non-technical side of the ship's history. When we do so we find revealed an amazing array of facts involving almost exclusively a clash of opinion, violent partisanship, personal animosity and professional jealousy. It would be easier to present an account of the battle of Trafalgar without mentioning Nelson's name or describing his character than to tell the story of the "Captain" without referring to the parts played in it by Sir E. J. Reed, Sir Nathaniel Barnaby and Captain Cowper Coles. The true circumstances which led up to the disaster cannot be fully understood and the true lessons of it cannot be fully gathered until we have before us some picture of Captain Coles as a naval designer, some explanation of Sir Edward Reed's behaviour towards him and his ship, some statement accounting for the fatal delay in the Naval Constructor's department to take action on the data which became available almost at the last moment, but still in time to have saved the ship.

All the stories which we shall tell will not embody personal aspects to the same extent as do those of the Tay bridge and the "Captain." In some cases the personal side of the narrative will perforce have to be omitted because the information necessarily required before it can be dealt with is not available. In other cases it will be omitted because it is of minor consequence, the dominating interest of the disaster and the lessons to be learned from it being entirely technical. Admittedly there have been some disasters which can be correctly described as technical accidents, of which the prime cause has lain in the operation of some physical factor, the existence of which was unsuspected until the mishap occurred and drew attention to it. An outstanding example of this kind of disaster was the Meopham aeroplane accident, which first drew attention to the phenomenon known as "tail buffeting." There is clearly no room and no occasion for the introduction of personalities into the narrative of such a mishap. Its cause and the lessons to be derived from it are purely technical. Disasters of this kind are, however, very rare. In nearly every instance the human side lies on the surface or at least just beneath the surface of accidents and mishaps, whether they reach the proportions of historic disasters or whether they are of the multitude of minor incidents which pass almost unrecorded in the tale of man's efforts to control and apply the forces of Nature. One of the most valuable lessons to be derived from the series of articles taken as a whole will perhaps be the clear establishment of the fact that the true cause of disasters is nearly always to be traced to some human failure rather than to a failure of materials. A bridge may collapse because it was subjected to a load in excess of its strength. A dam may burst because its foundations were undermined by percolating waters. These are the technical reasons for the disasters, but before we can truthfully say that we know why the bridge or the dam failed we must, if we can, discover why the bridge was weaker than the circumstances required, why the foundations of the dam were such as to permit the percolation of water. All too frequently the ultimate cause is to be found in some error of judgment, some insufficiency of ability, some deficiency of workmanship—and sometimes in some less excusable characteristic—of those responsible for the design and execution of the work. If that statement sounds in any way platitudinous then all we need say in its defence is that in that respect it is on a par with the statements which have to be recorded concerning the causes of many disasters. The true explanation when it is found nearly always revolves round the existence of some simple predisposing circumstances which after the event are so obvious that we are left wondering why their inevitably disastrous influence was not foreseen.

Government and Labour

AN "Industrialist" contributes to our columns to-day a very outspoken article. He himself calls it a "gloomy" article, and many may think that he looks too much on the dark side of things and sees too little of the great work that, despite all, has been accomplished. Be that as it may, there are few manufacturing firms throughout the land who will not endorse from their own knowledge every word said by "An Industrialist"—himself an engineer of eminence. It has been manifest for many months—reports of the Select Committee on National Expenditure bear witness to it—that the governmental control of industry has from the start been defective. Too many people who know nothing about industry were, and still are, in high places. Instead of decreasing the cost of products and increasing the output, the systems introduced by these people have had the opposite effect. In fact, it may be said that the country would have been better served if industry had been subjected to only the bare minimum amount of control. But, as "An Industrialist" says, political influences were at work. They demanded that no one should make war profits. That was a good thing in principle, to which the whole nation would have subscribed. Fairly administered, it would have tended perhaps to reduce costs. But it was only put into action in one direction. The employer was restrained, whilst the workman was allowed to demand ever more and more. The result was, of course, that costs rose; for the labour costs went up with rising wages and the management had no inducement in the form of increased profits to keep them down by improved methods. Patriotism would have countered this double effect—indeed it has done so in great measure, despite all—if manufacturers had been given a free hand. But they were, and still are, subjected to all manner of control, which adds to their on-costs so that much of the good they might have accomplished is negatived. The bureaucratic method has not worked well.

It is frequently said that wages, salaries, profits, and the price-of-living necessities ought to have been stereotyped on the first day of war, and that nothing should have been allowed to alter them. That is an impossibly high ideal. The cost of all imported things was bound to rise, and the increased price would have weighed heavily on the wage-earning classes. Wages would have gone up to meet the greater price, and as wages rose so would the cost of production. But if preservation of the *status quo* was an impossibility, greater effort to limit the acceleration towards inflation might have been made. If, to take a single example, the

Engineering Advisory Council had been set up eighteen months ago, millions of pounds of unnecessary expenditure on civil engineering might have been avoided. An Industrial Council, such as that foreshadowed by Mr. David Bremner long before the war—see THE ENGINEER, January 10th, 1941—would have prevented the undue rise of costs in mechanical engineering. The Government did not seek advice in the right quarters, and the country is paying the price. It destroyed or subordinated to non-expert control the well-established methods in both civil and mechanical engineering, and put a brake on progress instead of accelerating it. Broadly speaking, it may be said that the Government has been trying to do two things at once. To effect a reform in social economics and to switch all industry over to war production. In an autocracy nothing of the kind could happen. Questions of equity, equality of sacrifice, and so on, would not be considered for a moment. The autocrat would decide what step should be taken to ensure maximum output, and would take it without regard to the feelings of anyone, high or low. In a democracy that cannot be done; it has the defects of its merits, and for the sake of the latter we put up with the former. At the same time the House of Commons has given certain Ministers autocratic powers up to a certain point. There is a general feeling that those powers have not been used adequately; both Left and Right seem to be in agreement on that.

But whilst justification for every word that "An Industrialist" says could be given by chapter and verse, his article may take too gloomy a view of industry as a whole. No one has a right to expect 100 per cent. efficiency, or even 80 or 90 per cent. under the exceptional conditions of the day. Numerous defects are bound to appear when industries are entirely revolutionised to meet war requirements. It seems ever so long since the war started, but as a matter of fact it is barely twenty-one months since it was declared, and little more than a year since the crisis fell upon the British Empire with the collapse of France. An optimist might justly claim that we have some right to be proud of all that has been accomplished in that short time; but he would not say that, therefore, we must rest content. Far from it. He would assert that what we had done was but an earnest of what we could do, and would welcome outspoken criticism, such as that of "An Industrialist," because of the constructive indications it gives of the directions in which improvement is to be sought.

Government, Industry, and Labour

By AN INDUSTRIALIST

IT is useless to flatter ourselves or each other that all is well regarding the output of munitions, for in truth the position is still deplorable. The blame must lie with Government, with industry and its management, or with labour, or with all of them, for indeed there are no other shoulders on which the burden of responsibility can be laid. Actually, each of these parties has its full share of sins, both of commission and of omission.

Our Government is supposed to be a National one, which means that party politics are eliminated for the period of the war, and that all must unite in providing sufficient resources in men and munitions to crush the enemy. There should be no thought of party issues, either now or in the future, and yet the occasions on which political influence appears are by no means rare.

The Government has been entrusted with almost complete dictatorial powers, which it uses to the full in many directions, but hesitates to apply them in others, where the need is self-evident. Even the Government itself must have been astonished at the cheerful manner in which its decisions have been received by those most directly affected. Conscription, for example, was accepted without a murmur, although there was obvious hesitation in its application.

Industry has accepted, with almost complete unanimity, the most stringent control of its activities and prices, and has submitted with good grace to taxation on a scale hitherto undreamed of, always, however, with a protest against a 100 per cent. Excess Profits Tax. The objection to this tax is not one of principle, and 75 or even 80 per cent. would have provoked no resentment. But at 100 per cent. the tax is obviously unsound. It discourages enterprise, hinders the increase of production, and promotes extravagance of every kind. Moreover, it was clearly raised to its present level in response to political pressure. The Chancellor must himself certainly be well aware that as an economic measure it is certain to be a failure.

It is, however, in its efforts to prevent inflation, the invariable sequel of war, that the Government shows an incomprehensible hesitation in going to the root of the matter. Success has been achieved in maintaining interest charges at a gratifyingly low level, while rationing and the encouragement of all forms of saving and investment are all to the good, but the most important factor, the continual growth of wages, has so far been ignored, and they have advanced by leaps and bounds among all classes of wage earners, and they are still advancing.

Large-scale agreements between employers' federations and the unions are continually sanctioning increases, and, besides this, the granting of unending detailed demands for sectional increases, largely unknown to the public, continues. Appetite grows with what it feeds on, and each concession gives rise to further claims. Those whose unfortunate duty it is to attend the meetings of employers' associations know full well how deplorable the position has become, and how much of the time of managers and directors is wasted on endless discussions and conferences. Employers' representatives have become weary and worn out until they are inclined to take the line of least resistance and to give way, and with E.P.T. at 100 per cent. and human nature still unchanged, there is small wonder.

The nation wishes its workers to be well and sufficiently paid, but the limits have been reached and passed long ago, and still the process goes on. Every rise in wages puts up the cost of production at each stage in the course of manufacture and distribution from the coal and ironstone in the ground to the final arrival of the finished article at its destination. Every commodity costs more; the cost of living goes up, and in the end no one is better off, while expenditure on the war effort rises daily. It is highly probable that any given item of war equipment costs us about twice as much as our enemies have to pay for the same thing.

What is the remedy? Simply to lay down, even at this late hour, that all wages and prices must be stabilised until the war is over. This action should have been taken at the outset. It is the only way and those in authority know it, and nothing but the political motive has prevented, and still prevents, this step from being taken. But the Government turns a blind eye to the major issue and amuses itself, and the rest of us, by detailed interference with onions, eggs, and the like.

Attention has frequently been called to the deplorable effect in increasing cost of the "time and lime plus profit" system of contract. There are instances where urgency prevents the fixing of a definite contract price at the start, but there is no excuse for an indefinite continuance of the system. There is always the alternative, at least on excavating and building jobs, of payment on schedule at fixed prices.

While Government Departments seem greatly concerned about the percentage of profit, they are curiously indifferent to the total cost of the job, which is all that matters. Usually a job on which the contractor makes a fair profit at a fixed price costs much less than one which is done by day-work, even where the contractor receives a very low percentage.

Space does not permit a full criticism of Government activity and inactivity; the subject is too vast, but one of the major sources of delay and inefficiency is the deep-rooted unwillingness of the Civil Servant to take responsibility or to make decisions on questions of principle. He continually loses himself in a fog of detail. His great anxiety is lest he should be caught out in a mistake or an excess of zeal. Everybody who accomplishes anything makes mistakes, even the most successful (with the reservation that he makes fewer mistakes than the average). This shirking of responsibility results in referring every question to someone else, or to some other Department, with the inevitable hold up. Even the business man, when he has joined a Government Department, is continually prevented from taking the action which he knows to be necessary, until at last his courage evaporates and his initiative becomes destroyed.

The Board of Trade at the moment provides a very striking example of indefensible delays in decision. Before goods urgently needed for war purposes by our Dominions can be shipped, it is necessary to secure licences. Applications for licences are held up indefinitely while interminable questions are asked regarding totally irrelevant details. Meantime, large quantities of goods of the utmost value for the production of war material are held up at manufacturers' works. All that is wanted is a decision as to whether licences will be granted or not. In the former event, our Dominions will get the goods; in the latter event, they will be made available for home requirements. Indecision renders them useless for either purpose, and the labour and material expended on their production have been wasted.

Every attempt of industry to get on with its job is hampered and held up by the continual interference of innumerable Government Departments, frequently in conflict with each other, each avid for detailed information and for form filling, and each ignoring the time factor, on the recognition of which all hope for rapid progress depends.

A manufacturer is asked to erect an urgently needed extension—the particular Department concerned gives the necessary sanction and approves the plan. At this stage all looks *couleur de rose*. But what happens next? Some Government architect criticises the plans, and after much delay suggests modifications (by no means invariably improvements). When this Department has been satisfied, still no progress can be made until some other Department, after long discussions, grants, or refuses, a building licence. Then another Department has to be convinced that steel and other supplies are necessary. Then A.R.P. Departments have to consider plans and specifications from their angle, and then come the camouflage people, who require drawings and sometimes models, and so on *ad nauseum*. With letters taking several days in transit (apart from the delay in answering them), with innumerable visits to interview the various authorities, and with endless calls from inspectors, the time goes on, and when the date first named for completion arrives it is lucky if the foundations are being laid—and meantime, Hitler marches on!

The tedious and overloaded machinery of the various contracts departments moves like a beam engine, and the same procedure is considered necessary for ordering a simple article of commerce as for the contract for a battleship.

Government bookkeeping is the despair of industry, and chartered accountants are necessary to do the work of junior commercial clerks. The head of a large business accomplishes more actual work and makes more decisions between breakfast and lunch than three fully-fledged Government Departments achieve in a fortnight. The control of industry can only be exercised satisfactorily by the minimum amount of interference with established commercial methods, whereas the fashion is to intervene more and more in every detail. Engineers and business men are diverted from the jobs they know by heart and have to learn the art of cajoling the innumerable authorities with whom they have to argue. They cease to become producers and become lobbyists and conference experts.

Now let us consider some of the shortcomings of the employers. Perhaps the most serious indictment against them is in many cases that they have been apathetic regarding night shifts and in many vital industries it still remains true that not 50 per cent. of existing machine tools are working for more than half of the available time. They have been even more unenterprising in the introduction, training, and employment of unskilled labour, particularly of woman labour. The machine tool industry is probably one of the worst in this respect. Many machine tool makers, even now, are employing no female labour at all, and many others only an infinitesimal amount. It is well known that no skilled labour is available, and that the only hope for retaining increased production is to introduce and train unskilled and female labour, so that skilled workers may be employed only on such work as demands the highest grade of ability. The extent

to which women labour can be used still is not realised by many employers. Nor have they shown sufficient initiative in upgrading semi-skilled intelligent labour to increase the entirely inadequate supply of setters-up. So long, of course, as many existing machine tools remain idle at night, it is economically unsound to continue to produce and import the vast quantities of new machine tools which are still being acquired. It is obvious that labour must be found for these new machines, and if this can be done, then labour can equally well be found to run existing machines during the night.

By unwisely competing for labour, and continually offering more and more attractive wages, employers have not increased the total labour supply available, but have simply taken each others men, thereby causing widespread disorganisation, and continually increasing the cost of production.

In the purchase of material, small tools and equipment of all kinds, some manufacturers have pursued a selfish policy, which has resulted in the accumulation in their stores of unnecessary supplies, with the result that other, equally important, establishments have gone short.

The unions after long and strenuous opposition to effective dilution have at last changed their attitude on the broad question, but through their local branches they are continually raising every kind of difficulty, and are wasting their own time and that of their employers in continual discussions and conferences. They are pressing for sectional advantages, first in one department, then in another, and each concession they obtain forms a jumping-off place for further demands. Earnings of labour have never been so high, and there is a complete failure to realise that these continual advances are reflected in the cost of every commodity, so that the cost of living goes up in a vicious spiral and war expenditure increases daily.

The Ministry of Labour does not hesitate to direct attention to the sins of the employer, but grants absolution in advance to the sins of labour. Here, again, the political motive is obvious. In fact, one is tempted to believe that the war is being fought less for the salvation of the country as a whole than for the present and future benefit of the trade unions. By recent regulations the reasonable control of labour by the employers is made impossible. In theory a man cannot leave an essential industry without the consent of the local labour exchange, but in fact the trade unions themselves are permitted to arrange for the transfer of labour by a side track. Even the movement or the retention of a single man involves endless discussions.

A man cannot, under present rules, be suspended, even for misconduct, unless he receives his pay during the period of suspension, which simply means that the only disciplinary measure is the granting of a holiday with full pay. Time-keeping is bad, not only is there absenteeism on a large scale, but a great deal of time is lost in starting after each break. Workmen are allowed three minutes' grace in "clocking-on" after a break. If this time is exceeded a quarter of an hour's pay is stopped, but it is the invariable practice in such cases for the workmen not to begin work until the quarter of an hour has elapsed.

Instances are frequent of men on piecework slacking off when they have accomplished what they consider a sufficient output, though they could largely increase it without approaching the point of overstrain.

In certain industries restrictions on output are permitted to continue. This applies particularly to the building trade, where bricklayers are compelled to restrict the number of bricks they lay to a figure far below a fair day's work, and this continues despite the shortage of bricklayers (or perhaps, in fact, because of it).

Quite apart from questions of wages, labour is taking advantage of the present situation to press for the right to interfere in many new directions. The most recent demand is for the right to intervene in connection with apprentices, and if this is granted a blow will be struck to the apprenticeship system from which it can scarcely hope to recover, and which will probably result in its abandonment. Engineers know that the apprenticeship system provides not only the really skilled workmen of the future, but the most efficient charge hands, foremen, and managers, to say nothing of directors and heads of business enterprises.

Attempts are being made, further to increase the authority of the shop stewards, whose activities in so many instances, far from helping the war effort, do everything possible to delay it.

This is a gloomy article, but we have had enough of the prophesying of smooth things, and it is high time that the truth be spoken. It is only by realising our shortcomings that there is any hope of amendment, and unless we improve all along the line, what hope have we of succeeding in the desperate conflict in which we are involved?

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

SANDBERG, SHELLS AND SORBITE

SIR,—I note in your obituary of Mr. C. P. Sandberg that "during the 1914–18 war, the application of the Sandberg sorbitic treatment to H.E. shell forgings restored to serviceability millions of these forgings that had been rejected for low yield, and it may be added that the use of his process was given by Mr. Sandberg to the Government free of all royalties."

May I tell a little story from my own experience, not only to emphasise the value of a process which I now understand was devised by Mr. Sandberg, but more particularly to encourage others to stand up against arbitrary authority when it is restrictive of the output of munitions.

In 1916 or 1917, during the last war, quantities of American billets were delivered to the factory at which I was engaged. The material was of excellent quality, but mostly so soft that most of the forgings made from it failed to pass the tensile test, and were consequently rejected. The situation was rapidly becoming extremely serious, when one day the general manager told me that a visitor (who may have been Mr. Sandberg himself, for all I know) had just informed him that if the shells, immediately after forging, were stood on end and filled to the top with cold water, which was then allowed to boil away, their tensile strength would then be all that was required. He, however, reminded the G.M. that any such procedure was explicitly forbidden by the Government specification, and could not therefore be adopted.

We went straight to the forge, ordered a bucket of water to be brought, and poured it into the very next shell that came from the press. The succeeding shell was allowed to cool naturally as a control. As soon as both were cool enough to handle, test pieces were taken, with the result that the water-cooled forging was all that could be desired as regards tensile strength and nature of fracture, whereas the other one failed as usual to pass the tensile test.

Good enough! Water pipes were immediately laid on in the forge to make filling easier, and channel irons were arranged to hold the shells upright during the operation. Every shell got its dose of water as soon as forged, and scrapping, due to softness became a thing of the past. Indeed, the mountains of scrap forgings in the yard were brought back as opportunity offered and passed again through the furnaces, to be cured of their softness by water treatment. All this went on openly under the eyes of the Woolwich Inspectors, with which both forge and shops were swarming.

One day, just when everybody was happy again, some "Brass Hats" from Woolwich visited the works. On their way out they passed through the forge, and when they saw what was going on they simply "went in off the deep end." When they had recovered their breath they gave orders that from that instant not one single shell should be so treated, whatever the reason and whatever the result.

We knew, of course, what would happen. In a very short time I had to report to the G.M. that we were making nothing but scrap in the forge and that in forty-eight hours or so lathes would be standing idle for want of forgings. It was therefore decided to revert to water cooling, the argument being that, even if the shells were to be condemned by Woolwich eventually, the operators might just as well be working on them as doing nothing. As soon as the resident Woolwich Inspector saw what was happening there was, of course, a considerable row. After numerous telephone conversations with his chiefs he told us that, if we persisted, he had instructions to call off the whole of his inspecting staff and to refuse to test or pass anything whatever. He was informed that he could do what he ——— well liked; we had our own inspecting staff and should make our own tests and carry on exactly as before.

He thereupon withdrew his men and we were not worried in the least, in so far as ordinary production was concerned. But what we could not do, of course, was to pass the finished shells out of bond, as they lacked the official stamp. The consequence was that the bond, which held 10,000 shells, rapidly began to fill up. The G.M. by this time had got his back well up, and he was a man of iron determination. He made up his mind to bring the matter to a "showdown," for the shells were perfect in every way and the metal would pass any test that might be imposed. By the water treatment we had made good shells from bad metal, instead of making scrap, and it was no time for the authorities to insist on restrictive technicalities.

After several days had passed in this way he told me that he had been summoned to Whitehall about the business. As he got into his car his last words to me were: "You can expect a change in the management here, because I *won't* give way, and they *can't*." However, after a few hours he was back again, wearing a broad smile. He had been invited to attend a meeting, presided over by Sir ——— ———, and had been solemnly informed by him that experiments on the water cooling of shell forgings made from the class of steel that he was using had been carried out with highly satisfactory results, and micro-photographs were handed to him in confirmation of this. He was therefore "instructed" to cool his 8in. forgings with water in the manner already familiar to him, and it was "recommended" that he should treat the 6in. forgings in the same way. As the 6in. forgings gave little or no trouble from softness, probably because of their thinner walls, the recommendation was ignored.

July 4th. M.I. MECH. E.

P.S.—We did win the war.

PRIME MOVER DEVELOPMENT AFTER THE WAR

SIR,—Builders of stationary engines of all classes must, I think, be speculating with some little anxiety on the probable development of the post-war markets for their goods.

Up to 1939 there is no doubt that the national electrical grid was bidding fair to supplant most other forms of power, save for special purposes, and was very often being installed under conditions where this form of power was neither efficient nor economical, but the war has pulled us all up with a round turn.

One of the essentials for satisfactory universal electrical development in any country is a likelihood of sustained peace. It is true that our national grid has stood up better than we might have expected so far, but that is admittedly due to the abandonment of its chief precept of a few super-stations, and to bringing back into circuit many old and even private plants to help out in an emergency; nor must we omit the heroic work of its employees to whom the nation owes more than it sometimes remembers. Nevertheless, its failures have been a useful guide to what might happen were the nation relying on electricity alone.

I confess that I see no sign of any regeneration in human nature so far which induces me to believe that this war will end war, any more than did the last; in fact, since the women have come into it, it seems to me that they resent its horrors less than they did when their part was to watch and wait, and if I am right, then it is clear that the only way to maintain peace in an armed camp is to be more powerfully armed than one's possible aggressors, and I cannot see any post-war atmosphere entirely favourable to the delicate bud of general electrification without adequate alternatives in reserve.

This view therefore favours the chances of continued development of all classes of prime movers and locomotives, each to suit its own duties and the pursuit rather of £ s. d. efficiency than any other factor affecting the choice of machinery, but there is also the political question.

If by chance the post-war years are to be embittered by labour difficulties, as some fear, there is a strong temptation for the engineer to install a form of plant requiring a minimum staff for its operation, and one which automatically passes all labour troubles on to the power station, or anyhow most of them, but if we curtail the opportunities for work, how shall we offer employment to the disbanded armies of to-morrow?

Then, again, there are the overseas markets, some of which can undoubtedly be best served by electrical development, as where water power exists in

abundance, but others of which, like Australia, might be better served by considering the advantages of gas power developed from indigenous wood.

There is no doubt that once a country is harnessed to the electrical chariot wheel completely, it is farewell to invention and initiative in every other field.

What chance, for example, has the gas turbine to show its rivalry to the steam locomotive or the high-compression gas engine, recently developed, to demonstrate its economies in independent plant ?

The war has, however, given us pause and time to think, and possibly some of the glamour of the all-electric country so ably painted by grid interests before the war will have tarnished a little in the light of experience, for in engineering, as in all else, variety still remains the salt of life, and uniformity spells decadence. S. P. CHRISTIE.

Itchenor, West Sussex, July 3rd.

"THE COMING CRISIS IN ELECTRICAL POWER TRANSMISSION"

SIR,—In his letter of June 30th (THE ENGINEER, July 4th, 1941), Mr. Garrard now admits that the system angle does enter fundamentally into any analysis of power system stability, so that it is he, rather than I, who was hitherto guilty of "ignoring the elemental considerations upon which stability theory is based." At any rate, we are now on common ground.

It is quite true, as he says, that natural load working does not banish instability ; but then I have never maintained that it did. Neither have I ever held or supported the view that a quadrature boosting transformer can of itself raise the power limit of any transmission system into which it is inserted. As a matter of fact, it is not very difficult to prove by orthodox power-circle analysis that a booster, as such, in no way affects the power limit, but only alters the system angle at which the power limit is reached. As I understand it, however, that is not the point at issue, where Taylor's particular use of quadrature boosters is concerned, for stability is not merely a function of load change, but of transmission distance for a given transmitted power.

The real point has been admirably put by Mr. Kipps in his reply to Mr. Garrard's parallel criticism of an article dealing with quadrature booster theory, published in a recent letter in your contemporary (*Engineering*, June 27th, 1941, page 515). As is by now well known, the Taylor booster of necessity functions in association with a "naturally loaded" transmission line, when its effect—measured in terms of voltages, currents, and phase angles—is indistinguishable from that of Rüdenberg's system of compound compensation of series reactance and shunt susceptance by means of series capacitors and shunt inductors. In both cases the no-load and full-load system angles are both zero (if resistance efforts are neglected). As far as I am aware, this was demonstrated in the laboratory of Birmingham University with the aid of an experimental quadrature booster some years ago.

In view of the fundamental nature of the issues here involved, and of the prevailing limitations of editorial space, Mr. Garrard will no doubt agree with me (and with the Editor) that further discussion might very well be postponed until Major Taylor's forthcoming I.E.E. paper on this subject is read or published. H. RISSIK.

London, S.W.6, July 7th.

A NEW WORLD

SIR,—May I disagree with the censure of yourself in the opening remarks of your editorial dealing with Colonel E. Kitson Clark's stimulating and informative article ? In devoting space to the problem you are 100 per cent. right.

It is becoming abundantly clear that most normal thinking men are firmly setting their teeth for the great task that lies ahead when brute force has at last been disarmed. But how are we to put into practice the ideas which are now crystallising unless we have the necessary power to operate ? The solution of this vast problem must follow the laws of Nature and grow—not be left to the magic of some "ism"—it will require time and an army of experienced brains.

Where do these experienced brains exist ? Is it not a fact that the real wealth of the community is produced by industry, using the term to apply to all activities which follow the winning of the raw material from Mother Earth to the finished product for service. The experienced brains that control this vast wealth-producing machine are largely centralised in our scientific and technical institutions. Is this, therefore, not the starting point to commence and organise, by bringing together representatives of all our principal scientific and technical bodies, to form a nucleus of the power which shall formulate and direct our activities in the new world ? Doubtless professional representatives outside the industrial field will also be required, but these could be called in as and when the main body required further guidance.

The general trend of responsible modern thought on our future national structure seems clear, but let us be sure that we have the right foundation before we commence to build. Let us organise to co-ordinate real knowledge and experience. Colonel Kitson Clark ends his article with the words "take counsel together," but such counsel must include all industry, and all industry is built by the service rendered through the engineer. JOHN D. TROUP.

Purley, July 7th.

Problems of Steel Supply

WE present below the answers of the Steel Controller to a number of questions :

(1) *Q.*—Are home and imported supplies of iron ore and scrap adequate ? Is labour force sufficient ?

A.—With regard to the first part of this question, the answer is "Yes." The Iron and Steel Control has been laying aside considerable reserves of home and imported supplies of raw materials and it may be said that with regard to both iron ore and scrap the position is very satisfactory ; this state of affairs could, however, be still further improved if more labour was available in iron ore mines and quarries and the scrap sections of the industry ; for example, the man power at the disposal of scrap merchants to-day is 25 per cent. less than pre-war.

(2) *Q.*—Is there any evidence of absenteeism ?

A.—No. The most that could be said is that certain areas are not so good as others, but, broadly speaking, the steel industry is not suffering to any undue extent from absenteeism. Had it not been for the support we have had from the men operating through difficult times the output of steel would be very much less than it is.

(3) *Q.*—Are supplies of finished steel adequate, especially for naval and mercantile purposes ?

A.—The total steel available is very much more than this country has ever had in its history. One must appreciate that steel is probably the most important raw material necessary for the war effort and that the uses of steel change very considerably in a war requirement compared with peacetime ; therefore, in making a proper use of steel for war some of the capacity required for peacetime operations may to-day find itself not fully employed ; but to employ such capacity simply for the use of the productive capacity would be neither economical nor desirable.

To build a transport aeroplane or heavy bomber at least 5 tons of high-grade alloy steels are required. This, perhaps better than any other illustration, reveals the wartime importance of alloy steels, the production of which in this country, according to official sources, is now vastly in excess of pre-war figures and sufficient to meet the heavy demands made upon the steel industry by arms factories engaged in every type of armament production. Before the war the British steel industry was designed to meet peace requirements, in which alloy steels, while of paramount importance, were in much less demand ; to adapt an entire industry to wartime needs is no easy matter, and it was feared that for a time at least it might be difficult to supply all essential demands for alloy steels. Fortunately, the change over was facilitated by the far-seeing increase in electric furnace and open-hearth capacity laid down just after the outbreak of war.

The industry's performance as a whole is the more notable when it is remembered that many of the industry's essential raw materials were formerly imported from sources now under Axis control. After the fall of France, the industry's raw material experts brought into operation alternative foreign sources of raw material supplies. This has entailed great adaptations at works and led to difficulties which have called for the greatest ingenuity on the part of the industry.

At the same time, from the outbreak of war up to the present time considerable quantities of finished and semi-finished steel have been imported, the opportunity being taken when the shipping position was still comparatively favourable to build up large reserves in Great Britain. Mild steel imports have now been substantially reduced, leading to a saving of shipping space when this is urgently required for other vital purposes. The imports of high-grade raw material supplies necessary in the production of special steels are being maintained at the highest possible level. To a great extent these materials are not available in any large quantity in this country, and it is considered advisable to conserve such of these supplies as we do possess. The Iron and Steel Control are in general doing everything they can to save shipping consistent with the maintenance of the steel output.

(4) *Q.*—Are there adequate stocks of ore and scrap, and semi-finished and finished products ?

A.—(1) and (3) meet this query.

(5) *Q.*—Are there any difficulties experienced regarding transport both into the country and from the makers to consumers ?

A.—So far as imports from abroad are concerned, during the winter months there were difficulties consequent upon congestion at the ports due to the very large quantities of material arriving, the restrictions in order to comply with black-out requirements and bombing raids. This had its reaction on home-produced supplies, through shortage of transport vehicles, both rail and road.

At the moment transport facilities are available to meet all requirements and the position is such that there is no delay in delivery of steel on that account.

(6) *Q.*—Are workers generally putting in their best : is there any dissatisfaction over wages or conditions ?

A.—This is to some extent answered by (2) and (3). The workers are adequately represented by a consultative committee which was established at the outbreak of war and has worked most happily. The Iron and Steel Control has also established a labour section which works in close co-operation with the Iron and Steel Confederation.

(7) *Q.*—Is the symbol rationing plan working satisfactorily ?

A.—Distribution is effected through the distribution of steel supplies scheme, which entails the employment of a system of authorisations and licences. Although at first sight rather formidable these regulations enable the authorities to keep a finger on the pulse of the steel industry all the time. The scheme has been accepted with a good grace by steel manufacturers and consumers, who appreciate that no other mechanism would be adequate. It was amended and simplified in the light of experience gained after six months' operation and to-day there is little, if any, use of steel except for absolutely essential purposes.

The construction of cinemas and all other unnecessary buildings has entirely ceased ; civil consumption has been cut to the bone, and an authorisation form has to be obtained from the Government Department concerned. The steel so obtained comes out of one or other of the Government Department's allocation of steel.

For convenience sake each Department has its own symbol ; for example, the Board of Trade, which is responsible for civil consumption and export, has the symbol B.T. In the same way the Admiralty is A.D., the War Office W.O., and so on. The amount or ratio of steel allotted to each Department is agreed by an inter-departmental committee, called the Materials Committee. A symbol, therefore, must be quoted with all orders placed with steel works, and this automatically places the responsibility with the Department whose symbol has been used.

The information so obtained enables the Iron and Steel Control to keep a tight grip on the use of steel for all purposes and plan for the future. This last is done by stating on every authorisation the period (quarter) during which the steel must be delivered, even a year or eighteen months in advance.

(8) *Q.*—What is the effect on production of alerts and black-out conditions ?

A.—This, naturally, varies in different districts ; but, thanks to the Observer Corps warning system, there has, broadly speaking, been little loss. It should be borne in mind that the steel industry differs from practically any other in respect of the immense glare and amount of light thrown off during operations. Consequently, the necessity of achieving a good black-out has entailed some loss of ventilation. The men have stood up remarkably well to the somewhat more trying conditions under which they work.

(9) *Q.*—Is there any increase of price likely ?

A.—So far as the immediate future is concerned, with the exception of certain minor alterations, no.

(10) *Q.*—What is the position of hematite supplies, in which there has been reported to be some difficulty ?

A.—Supplies of hematite are adequate for all essential war purposes. As, however, a large proprotion of the hematite used in this country has to be imported, the Iron and Steel Control rigidly allocate supplies so that works needing hematite are in effect rationed. It is unlikely that this position will improve for the duration of the war.

(11) *Q.*—Has proportion of scrap used in manufacture been changed ?

A.—British steel works to-day are not, generally speaking, using more scrap proportionately than in the past.

In addition to the foregoing questions and answers,

"VALENTINE" INFANTRY TANKS

the two following points may be of interest:—

While doing everything possible to maintain production, various methods have been studied by the Iron and Steel Control to effect economy in the use of steel. This research has led to the use of material lighter than that normally specified and considerable economies have been achieved amounting, in some cases, to many thousands of tons per annum. Two typical examples are the reduction in the weight of tubes for gas, water and steam purposes and insistence on the use of light-weight tubes wherever pressures are suitable, and an order restricting the use of tin-plate containers, which specifies the gauge of material to be used. The first will, it is estimated, save 20,000 tons of steel and the second between 30,000 and 40,000 tons of tin-plate per annum.

In the spirit of the President of the Board of Trade's request to industry to telescope production wherever possible, the Iron and Steel Control has made a close examination of the position as it affects iron and steel. Those sections which are of an essentially peacetime nature and do not lend themselves to wartime requirements are being looked into and production will be telescoped wherever possible.

The "Valentine" Infantry Tank

THE Ministry of Supply has issued brief particulars of the new "Valentine" infantry tank, which we illustrate herewith. Up to the present time it had been known as the Mark III type. Its general design and wheel arrangement will be seen from the accompanying engraving, which shows two of the new tanks. The design of the "Valentine" is, we are informed, a development of the "Waltzing Matilda" unit, which was ceremoniously so named a few days ago by a unit of the Royal Armoured Corps. Each of the new tanks is designed to carry a crew of three. They have a high factor of manœuvrability and are engined to give a road speed of more than 15 m.p.h. The armament in the main turret comprises, besides a "Besa" gun, a 2-pounder gun, which fires a projectile which has been designed to pierce the armour of any tank yet met with in the German armoured formations we have engaged. This new type of armoured vehicle has undergone careful and complete tests by War Office experts and tank officers, and as a result of the trials which have been carried out it can be stated that "Valentines" will cruise across open country in a manner comparable with the performance of a car on a good road. Full details of the performance and armouring cannot, of course, be revealed at present, but it may be stated that for the weight of guns and armour carried the "Valentine" tank is much faster than was at first expected. The armament is powerful enough to destroy any other type of machine which these tanks are likely to encounter.

Obituary

DR. JOSEPH WARD

THE city of Sheffield has lost a leading figure by the death, on Monday, July 7th, at his home, "Endcliffe Grange," of Dr. Joseph Ward, the chairman and managing director of Thos. W. Ward, Ltd., of Albion Works, Sheffield. Dr. Ward, who was seventy-six years of age, had been seriously ill for some weeks past. He was educated in Sheffield, and in 1878 he joined his elder brother, the late T. W. Ward, who was the founder of the firm which bears his name. In 1889 Joseph Ward entered into partnership with his brother, and in 1904 became joint managing director of the company, which was then incorporated as Thos. W. Ward, Ltd. In 1919 he was elected chairman of the company, a position which he continued to hold until he died. Joseph Ward took a leading part in the formation of the Ketton Portland Cement Company, Ltd., which he served as chairman and managing director. Other firms of which he was also chairman include Ribblesdale Cement, Ltd., Thos. Smith and Sons (Rodley), Ltd., the Midland Iron Company, Ltd., Marshall, Sons and Co. (Successors), Ltd., besides many of the subsidiary and associated companies in the Thos. W. Ward organisation. His long experience in the iron and steel trade, especially on the side of scrap metal and shipbreaking, earned for Mr. Ward a place as one of the leading authorities on those subjects. During the last war Joseph Ward served in an advisory capacity on questions of iron and steel scrap to the Ministry of Munitions. In 1931 Mr. Ward was elected Master Cutler. His work as chairman of the Applied Science Department and latterly as treasurer to the University of Sheffield earned for him the gratitude of the University, which conferred upon him the honorary degree of LL.D. in 1939. For many years he was a great benefactor to religious and charitable organisations, both local and national, and his consideration for the welfare of his employees was marked in many ways.

Sixty Years Ago

A STEAM TRICYCLE

IN 1881 Sir Thomas Parkyns made use on the public highway of a steam tricycle which he had invented. The machine consisted of an ordinary tricycle with the addition of three metal boxes containing, according to a note in our issue of July 8th, 1881, "a complete steam engine, a condensing apparatus and a reservoir containing methylated spirit, designed to be used for the generation of steam." The machine was said to be capable of travelling at a rate of 10 miles an hour without any escape of steam or showing any indication of being driven by steam. Sir Thomas was duly summonsed to appear before the police magistrate at Greenwich for committing an offence against the Locomotive Acts of 1865 and 1878. The magistrate was of the opinion that the machine was not within the mischief contemplated by the Acts, but nevertheless felt bound to convict Sir Thomas on the grounds that a "locomotive" was defined in the Acts as "a locomotive propelled by steam or by other than animal power." He inflicted a nominal fine of one shilling. Sir Thomas appealed against the magistrate's decision. His counsel argued that the Acts were penal statutes and that as the tricycle had been found not to be within the mischief of the Acts it ought not to be held to be within them. It was also pointed out that the requirements of the Acts not to travel at more than 2 miles an hour and to have three persons in attendance would prevent the use of the machine. Lord Coleridge, who heard the appeal without calling on counsel for the respondent, decided that the tricycle was a locomotive within the meaning of the Acts and upheld the magistrate's decision.

The L.N.E.R. Train Fire Report

ON Saturday, July 5th, the Ministry of War Transport issued the report of Colonel A. C. Trench on the fire which occurred on the 12.45 p.m. King's Cross to Newcastle express on which 100 boys were returning to Ampleforth College. The fire took place about 3.30 p.m. on April 28th, near Westborough signal-box on the Grantham-Doncaster main line. The coaches were of the company's standard construction with timber bodies on steel underframes. In his conclusions Colonel Trench says that it is clear that the origin of the fire was due to matches which were admittedly flicked about by some of the boys, one of which fell between the side of a seat and the side of the coach and started a small fire in a very inaccessible position. As a result of experiments he has made Colonel Trench does not think that the fire originated from a cigarette end. There was, he says, among the boys an unfortunate lack of appreciation of the fact that in a vehicle moving at high speed the draughts which usually exist are likely to cause the rapid spread of any fire, so that immediate smothering action is essential. With regard to the time taken to stop the train after the communication cord was pulled, he mentions the fact that the speed reduction curve for any brake application is convex and is very flat in the initial stages, so that the reduction from 55 m.p.h. to, say, 40 m.p.h. may take about as long as for the remainder of the time from 40 m.p.h. to a stop. On the question of the locking of the gangway doors, Colonel Trench is of the opinion that in the case of unoccupied brake vans, whether at the leading or the trailing ends of a train or whether they are located intermediately, there is adequate justification for maintaining the existing practice of locking the doors. He questions, however, the justification for locking corridors and gangway doors between passenger accommodation of differing classes and suggests that in the case of composite coaches with end doors only, the locking of a corridor halfway down the coach between first and third is undesirable. These last two points, he suggests, merit consideration by the companies with a view to an amendment of existing regulations. In the matter of the fire risk of the construction and equipment of the coach, Colonel Trench says that his experiments showed that uncovered plywood was materially more resistant to a flame than was plywood covered with Rexine. Further, with regard to the inaccessibility of the backs of the seats, he suggests that it might be advisable to omit the layer of wadding and Rexine covering at present used, leaving the plywood backs of the seats bare.

The Retirement of Mr. A. H. Hall

ON Thursday, July 3rd, it was officially announced by the Ministry of Aircraft Production that Mr. A. H. Hall had retired from the post of Chief Superintendent at the Royal Aircraft Establishment, Farnborough. He was due to retire in April last, but consented to continue in his post until July 4th. Mr. Hall was in charge of the Royal Aircraft Establishment, Farnborough, since 1928. After a distinguished career at Cambridge, he gained his B.A. degree and entered the public service in 1904. During the last war he was Director of Mine and Torpedo Production at the Admiralty, and in 1926 became the Superintendent of Production at the Royal Airship Works, Cardington. The technical superiority of British aircraft over German is in a material degree due to Mr. Hall's work. Mr. W. S. Farren, who was until recently Director of Technical Development at the Ministry of Aircraft Production, has been appointed Director of the Royal Aircraft Establishment, Farnborough, in succession to Mr. A. H. Hall. In the last war Mr. Farren was an experimental engineer and pilot. He is forty-nine years of age, is a Fellow of Trinity College, Cambridge and University Lecturer in Aeronautics. He joined the Air Ministry as Deputy Director of Scientific Research in 1937.

THE AMARILLO HELIUM PLANT.—The United States Bureau of Mines has taken measures to protect its plant at Amarillo, Texas, which is the world's sole producer of helium. The Bureau wants to ensure that no interruptions will occur to operations at the helium plant, so that production of gas and shipment to the Army and Navy for defence purposes may continue. The Amarillo plant has produced more than 110,000,000 cubic feet of helium, virtually the entire supply in the world, since it first began operations about twelve years ago. The plant has a capacity of 24,000,000 cubic feet annually, and the Government's gas wells near the plant have a capacity of 20,000,000 cubic feet, but the latter will soon be augmented to equal the current plant capacity. There are proposals now in Congress to increase both well and plant capacity to 36,000,000 cubic feet annually. During the last fiscal year, the plant produced nearly 9,500,000 cubic feet of the gas, and at the current rate of production it will have produced about 14,000,000 cubic feet by the end of the present fiscal year. Approximately 85 per cent. of the output is supplied to the Government, the remainder being sold for medical, scientific, and commercial use.

Ball and Roller Bearings*

By P. PRINGLE†

THE majority of electric motors built in recent years are fitted with ball or roller bearings, and it is hoped that this article based on the experience gained over a period of many years will help in recognising certain forms of trouble. Such cases are rare, but if trouble is quickly recognised, it is usually possible to prevent its recurrence.

Failure rarely occurs without warning, and unless the bearing is in an inaccessible position this warning can be detected, mostly in the form of noise, but sometimes by roughness or heat. Trouble discovered

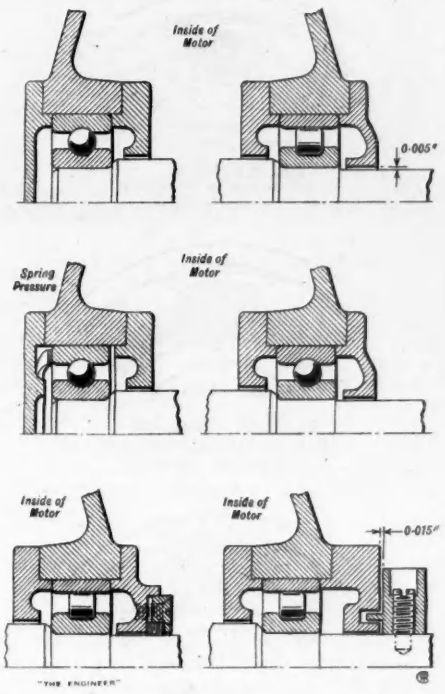

FIG. 1—*Typical Arrangement of Ball and Roller Bearings on Motor*

FIG. 2—*Arrangement of Spring-loaded Ball Bearing*

FIG. 3—*Sealing Arrangements on Roller Bearings*

in time can often be alleviated by flushing the bearing with paraffin and re-lubricating it until it can be more conveniently removed.

When it is necessary to replace a bearing, much time and temper can be saved by using proper withdrawing tackle and having a correct spare bearing available. It is important that the spare bearing should be correct as regards both external dimensions and internal clearances; a motor-car bearing obtained from a garage is not necessarily suitable for an electric motor. Where types and sizes of electric motors are standardised and bearing particulars are tabulated, there is likely to be less difficulty in replacing a bearing.

OPERATING CONDITIONS

The manufacture of ball and roller bearings is a specialised process, and trouble is rarely experienced

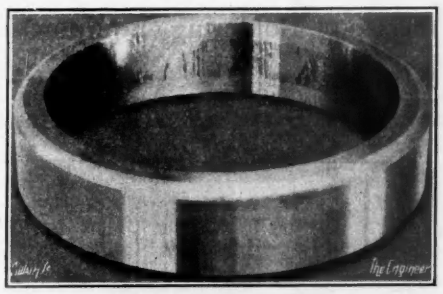

FIG. 4—*Effect of Transit Vibration on Roller Bearing, Accompanied by Angular Movement of Inner Race*

with the bearing itself as a manufactured product, but rather with the conditions under which it is operated. The conditions essential for successful operation can be tabulated as follows:—

(1) The highly finished working surfaces must not be damaged.

(2) The mounting must be correct, the seatings being truly circular, of the correct size, and with square retaining shoulders.

(3) The lubrication must be adequate and the bearing must be clean.

(4) The design of the bearing must be suitable for the speed and loading.

The foregoing tabulation is convenient for the consideration of possible faults, but does not necessarily indicate the order of their probability.

The most usual arrangement of bearings on an electric motor, and the one generally referred to in this article, is shown in Fig. 1—a parallel roller bearing at the driving end and a single-row ball bearing at the non-driving end. With this arrangement the outer race of each bearing can be gripped by the bearing cap and creep is prevented. The inner race is a press fit on the shaft.

POSSIBLE TROUBLES

If trouble develops and the bearing can be opened up before failure occurs, it is usually possible to ascertain the cause; but if the bearing is run to destruction the evidence itself is probably destroyed. If condition (1) or (2) is at fault there is usually clear evidence in marking of the bearing and trouble is likely to develop early in its life. If condition (3) or (4) is at fault the trouble may not develop until

FIG. 5—*Effect of Transit Vibration on Roller Bearing, with No Angular Movement of Inner Race*

after several months of service. One difficulty is that some forms of trouble, such as cage wear, for example, may not be due to just one condition. It may be instructive, therefore, to analyse certain failures and their possible causes.

Suppose condition (1) is at fault and the highly finished working surfaces have been damaged; the result will usually be a whistling noise at full speed, declining to a clicking sound as the bearing slows down. Bearings may often run for a long time after this trouble has occurred, but the damage is likely to spread and ultimately result in complete breakdown.

Variations of this fault may occur as follows:—

(1*a*) If a coupling is hammered on to a motor fitted with ball and roller bearings, and the shaft is not supported endwise while this is done, the balls may cause a series of indentations in the inner and outer ball races. It is not easy to see these, but they can be felt by hand in bad cases.

(1*b*) In a roller bearing the outer race and rollers

FIG. 6—*Effect of Standstill Vibration on Roller Bearing*

can be more easily examined, but it is more easily damaged in assembly than a ball bearing. Its outer race may be forced over the rollers slightly on the cant, and the rollers may score the outer race from the edge of entry to the final position. Very little indentation is needed to cause noisy operation.

(1*c*) If a roller bearing is subjected to vibration while standing still, the outer race may become scored where the rollers touch it, especially at the bottom. The inner race may be correspondingly scored and the rollers marked. If this condition occurs more than once there may be more than one set of markings. This form of trouble is generally called "transit vibration" and is liable to occur during long rail journeys or transport over rough roads. Its incidence may be lessened by wedging the shaft endwise in the packing case and mounting the packing case on flexible pads. The same symptoms may occur in a roller bearing standing still for long periods while subject to the vibration of other machinery, as, for example, in motors for power-house auxiliaries. This may be called "standstill vibration," and the markings may become more severe than in the case of transit vibration. Obviously, the effects of transit vibration can be cured by replacing the bearing on site; but standstill vibration may be recurrent unless the external vibration can be reduced. Troubles due to standstill vibration are more rare than those due to transit vibration. These faults do not occur in sleeve bearings nor in machines with two ball bearings spring loaded as shown in Fig. 2.

(1*d*) Shaft currents circulating through ball or roller bearings soon cause marking of the tracks and dulling of the balls or rollers. The track is marked in close-pitched bands, as shown in Fig. 7. This trouble is very rare; it has never been found in induction motors, but if certain design factors are not right in alternators or variable-speed commutator motors its occurrence is possible though extremely rare.

If pedestal bearings are used a cure can be effected by insulating the pedestal or providing an earthing brush; but the machine designers should be consulted, for the surest remedy is to remove the cause. Even sleeve bearings are affected by shaft currents, which cause pitting and oil sludging.

The foregoing troubles have been dealt with first,

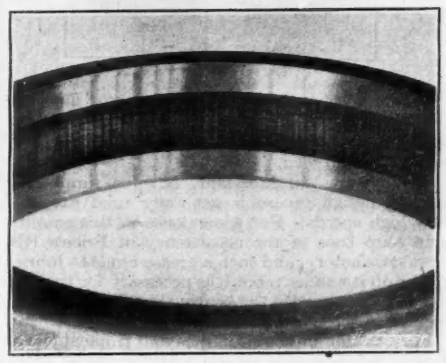

FIG. 7—*Roller Bearing Damaged by Shaft Currents. The Track is Blackened, with Close-pitched Transverse Markings*

not because they are the most common or the most probable, but because their symptoms are unmistakable and the troubles can be diagnosed quickly. Troubles are more likely to occur due to errors of mounting.

ERRORS OF MOUNTING

If the outer race of a ball or roller bearing is canted the error will show in the marking of the outer race. The marking will tend to wander from one side of the centre line to the other. Marking on a ball bearing outer race is not so easily disclosed; it can only be seen by dismantling the bearing and examining the track very closely, preferably rotating it in a good light. Inner races may be marked in the same way if they are not mounted squarely. To guard against

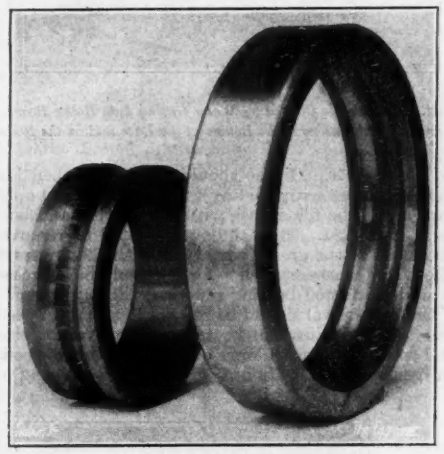

FIG. 8—*Ball Bearing Damaged by Shaft Currents*

this it is advisable to see that the shaft shoulders are not bruised and, if possible, to skim them in a lathe.

Incorrect mounting can be judged by the marking of the tracks, and if there is additional appreciable load the tracks may break down at the worst point. Other faults may be due to the same unsuspected cause; cage wear and vibration (particularly if the vibration is worse axially than radially) can frequently be traced to want of squareness. This can best be measured by a step micrometer from one race to the other at four points, but this is not generally available and a clock indicator can sometimes be improvised. Obviously, self-aligning bearings remedy this fault, but as they introduce their own problems they are not so frequently used.

In the bearing arrangement shown in Fig. 1 the outer race should go into its housing with a light tap fit; it is better to have an easy fit than a tight one.

With the arrangement shown in Fig. 2 the bearing

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† B.T.H. A.C. Engineering Dept.

at the spring end should slide in the housing so that the spring can exert end pressure on the bearing. In both cases the inner race should be a press fit or should vary between 0·0002in. and 0·0009in. interference in typical cases—say, 1in. to 2in. bearings. Insufficient interference and lack of squareness may both help to cause the inner race to rotate on the shaft and thus result in wear. A bearing that is too tight a fit on the shaft and has too little internal clearance will fail by gripping the balls, causing banding as shown in Fig. 9.

LUBRICATION

All ball and roller bearings need lubricating even though they do not need much. Inadequate lubrication will cause cage wear and the bearing will ultimately break down.

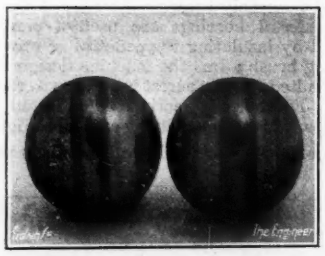


FIG. 9—*Banding Caused by Too Little Internal Clearance*

Oil is the ideal lubricant, but for simplicity in housing design grease is generally used except for very high speeds. For general use in this country a soda soap base of the consistency of Price's RB is most satisfactory, and such a grease tends to lubricate by the oil it exudes ; but it is necessary for the grease to be in contact with the bearing itself and not merely present in the housing.

For working in hot situations and tropical climates it may be preferable to use a stiffer grease such as Price's HMP.

A replacement bearing should first be washed in clean paraffin and then a few drops of light machine oil put into it. Grease should then be pushed into the free spaces with the fingers. The inner and outer caps should be filled flush with the bearing and both caps assembled. Then the outer should be removed and some of the grease wiped out with the fingers to afford the necessary relief for the contained grease. A well-lubricated bearing may run slightly warm.

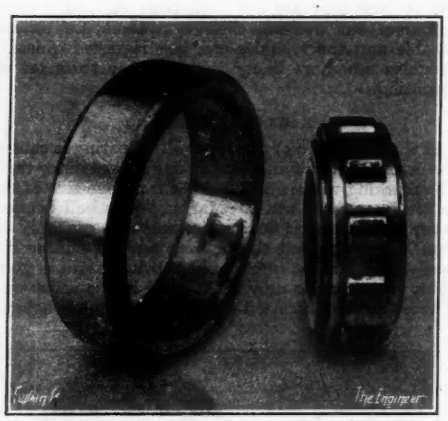


FIG. 10—*Damage Caused by Water Getting Into Roller Bearing. Brown Discolorations at the Bottom of the Race and on the Rollers*

Grease renewal should be related to size and speed, and more liberties can be taken with average sizes and speeds than with large bearings and high speeds. In general the contained grease in a bearing of average size and speed should last for six to twelve months, after which a thimbleful of grease should be added. A very good article on this subject appeared in the *SKF Ball Bearing Journal*, No. 4, in 1937.

EFFECT OF WATER AND ACID

Moisture is harmful to the bearing. Water may possibly get in if the motor stands in store for a long time or works in an exposed position ; it causes damage to the tracks in patches of a brown etched appearance where it happens to collect.

Acid fumes are destructive if very strong ; they cause the races to have a mottled and etched appearance and the bearing quickly develops wear and excessive clearances. Fig. 11 shows a bearing after working for three months in very bad acid fumes. Liquid acid is, of course, even more destructive.

Abnormally dirty, wet, abrasive or fume conditions may sometimes justify bearing housings of special construction. It should be remembered that a well-made totally enclosed motor tends to breathe through the driving end bearing. Experience has shown that bad abrasive dust conditions can be met by the re-entrant sleeve shown in Fig. 3, and a well-made cork seal can be used for wet conditions. Both these conditions justify more frequent renewal of grease than normal.

FIG. 12—*Cage Wear on a Ball Bearing*

CAGE WEAR

Perhaps one of the more common troubles on ball and roller bearings is cage wear ; this is usually due to inadequate lubrication, although there may be other causes. Mounting out of square causes cage wear in rigid bearings, and design and speed must be taken into account in dealing with the problem. In fact, the three main questions to be asked are : (*a*) Is the lubrication right ? (*b*) is the bearing square ? and (*c*) is the speed such that wear can be reduced by detail differences in bearing design ?

In a single-row ball bearing the cage may be pressed or it may be machined from tube and drilled for the ball pockets. For ordinary speeds there is little to choose between these two constructions, but the pressed cage is more open and allows the grease free access to the balls.

The pressed cage is formed to the shape of the balls and is centred by them. The drilled cage has a parallel hole and the inner diameter usually rubs on the inner race. Where speed increases beyond a certain range better service is obtained with a drilled cage if it centres on the balls rather than on the inner race. This can be effected by special shaped ball pockets, increased clearance being provided between the cage and the inner race. The various types are shown in Fig. 13.

In general roller bearings suffer less than ball bearings from cage wear, as mostly the drilled cage pocket encircles the roller, though it may also rub the inner race.

It is sometimes thought that ball and roller bearings need have no internal clearance ; but actually it is important to have the correct clearance. Bearings are usually classified as 1, 2, or 3 dot for clearance, such classification being indicated by spots or circles polished on the outer race. There is no precise agreement among the makers regarding these clearances ; but 3-dot is the slackest and is generally used for electric motors, although in more recent designs some B.T.H. motors have been fitted with 2-dot bearings. One-dot bearings should not be used for electric motors, as too tight a bearing may result in marking as shown in Fig. 9.

NOTE.—In all the above the rubbing zone on the ball with regard to the cage is shaded

FIG. 13—*Methods of Cage Construction*

For small motors there are definite advantages in using two ball bearings and spring loading them to eliminate clearances as shown in Fig. 2. This arrangement distributes the load on the cage to all balls and facilitates the production of very smooth-running motors.

In these notes the simplest types of ball and roller bearings for electric motors have been dealt with in detail, but even with more difficult cases the difference between success and failure is usually only a matter of detail.

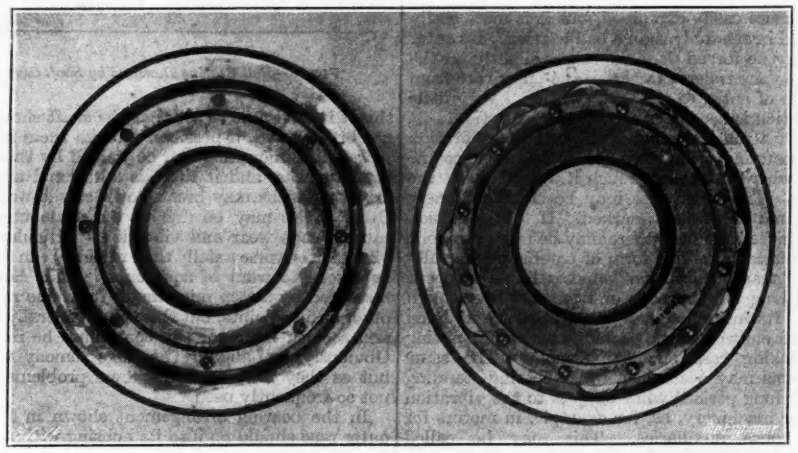
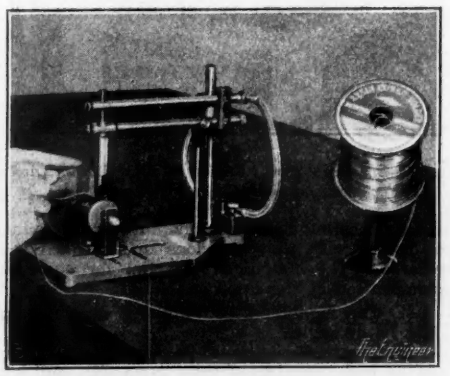


FIG. 11—*Bearing Damaged by Acid Fumes. Light Etching Discoloration of Steel Parts Exposed to Attack*

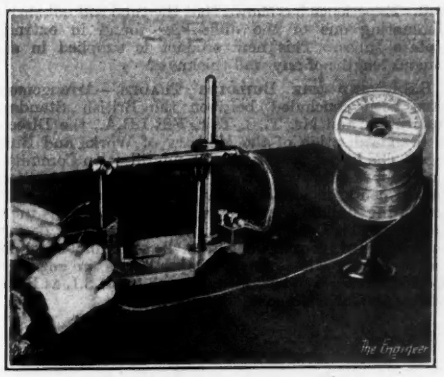
Electrode Soldering Equipment

IN two accompanying engravings we illustrate examples of bench electrode soldering tools made by Stanelco Products, of Northwood. They scarcely need description, but it may be mentioned that these handy tools, of which there is a larger range than that illustrated, are intended for the soft or hard soldering of multitudinous parts. The heating, performed electrically, is localised to the part being soldered and current is consumed only when the tool



DOUBLE ELECTRODE SOLDERING TOOL

is being operated. The operating voltage is low and a range of five transformer units is available for serving the tools with outputs between 100 and 2500 watts. These transformers are wound for voltages of 100/110 and 200/250. Of the two tools illustrated, the first has a double-electrode arm, terminating in an electrode copper soldering bit. It is designed for the soldering of metal parts assembled in non-

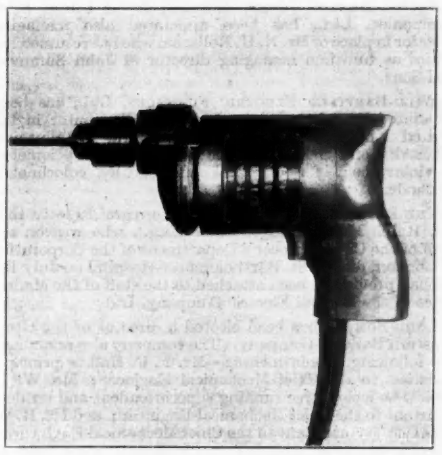


SINGLE ELECTRODE SOLDERING TOOL

conductive material. In the other there is a single-electrode arm designed for the local heating of parts to be soldered and the return circuit is *viâ* the metal base. Among other tools operating on the same principle may be mentioned one specially designed for soldering cables into togs or plugs.

Universal Electric Drilling Machines

THE accompanying engraving illustrates the 806–808 "Midget" drill, made by the Consolidated Pneumatic Tool Company, Ltd. It is suitable for production drilling in aeroplanes, motor vehicles, radios, refrigerators, wood and metal furniture, &c., and for close quarter work generally. Ventilation of the motor is obtained from air intakes at the end of the handle, where they will not pick up chips and dirt. The intakes are not covered by the operator's hand, and ventilation is in no way restricted while the machine is at work. The exhaust air blows over the gear case towards the work, thereby keeping the whole of the tool cool. The tool has a pistol grip, and is operated by a switch "trigger." Two separate



"MIDGET" DRILL

castings are used for the stator and switch housing, and as the upper armature bearing is mounted in the stator housing, a blow on the switch handle will not distort the bearing alignment. Cable renewals can easily be made without disturbing the switch. The gear case contains a pair of helical gears for quiet running. All ball bearings are mounted in steel inserts, cast in place.

This tool is available with a wide range of speeds, the standard being 3500, 5000, and 2500 r.p.m. The former two speeds have a capacity of $\frac{1}{16}$in. and the latter of $\frac{1}{4}$in. in steel. The tool weighs only $3\frac{3}{4}$ lb. The overall length, namely, $7\frac{5}{8}$in., and the spindle offset of $\frac{3}{4}$in., permits the tool to work in reasonably confined spaces.

MEXICAN RAILWAYS.—The Mexican Government has granted a concession to the Cia. Mercantil, Industrial y Constructora to build a railway, 280 miles long, to connect the states of Oaxaca and Chiapas. According to the *Railway Gazette*, the company has now raised funds totalling 10,250,000 dollars, and construction of the line is to begin.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

The United States Market

Great activity continues to rule at the steel works in the United States, and much interest is taken in expanding the production. Plans which are being prepared for increasing outputs on the Pacific Coast will probably include at least one or possibly two blast-furnaces for the United States Steel Corporation's subsidiary and another for the Colorado Fuel and Iron Company. It is also intended to increase the capacity of the steel works on the Coast by 1,550,000 tons per annum by four of the leading steel makers. Prices have not shown much change lately but the authorities appear to be keeping a watchful eye upon the position. The quotations for the third quarter are unaltered, and maximum prices have been fixed by an Order issued by the Price Administrator. Foundry No. 2 is 24 dollars, Bessemer 24·50 dollars, and basic 23·50 dollars, f.o.b. furnaces Pittsburg. Two independent furnaces are allowed to quote 50 c. per ton higher. In Eastern Pennsylvania prices are fixed at 25, 26, and 24·50 dollars respectively. Pig iron for export is quoted on the basis of the nearest basing point to point of production, plus differentials for analysis, &c., and charges for transportation to f.a.s. point of delivery. Tight conditions have developed in the American scrap market, and it is feared that if larger supplies of scrap do not become available, the production of steel ingots may suffer. Railway selection scrap, No. 1 heavy melting, is quoted at 21 dollars in the Pittsburg district, and dealers No. 1 heavy at 18·75 dollars at Chicago and Eastern Pennsylvania.

The Pig Iron Market

Stringent conditions still rule in one or two departments of the pig iron market, but on the whole the situation is satisfactory, and there has been no interruption to supplies of pig iron required for war work. Amongst the most consistently large consumers for some months past have been the engineering foundries who are almost fully employed upon Government work. Most of these engineering concerns require low phosphoric or hematite pig iron, but the Control is exercising careful supervision over the distribution of these grades, and wherever possible users are asked to substitute high phosphoric or refined irons. There is no scarcity of the former description, and, in fact, the Midland furnaces are producing on a heavy scale, and are understood to be holding substantial stocks, so that consumers can obtain these grades without any difficulty. The light castings foundries, which in peacetime are the largest users of high phosphoric iron, are only moderately employed, in view of the restrictions upon building, which is reflected in a poor demand for builders' castings. In some districts the demand from the light castings industry has recently shown signs of improving. Most of the allocations for July and September have now come to hand, and consumers have been busy placing their orders with the producers. The demand from the engineering foundries is a prominent feature of the Lancashire market, but those foundries which are not fully occupied on war work, such as the light castings and jobbing foundries are far from busy. A considerable tonnage from the Midland furnaces, however, is passing into consumption to the foundries associated with the machine tool trade. Tight conditions rule in the hematite pig iron market, and the producers are experiencing a steady pressure from consumers to obtain deliveries against contracts. Users of this class of iron, however, are carefully rationed.

North-East Coast and Yorkshire

Consumers of all descriptions are exercising considerable pressure to obtain supplies from the North-East Coast steel works, which are operating practically at capacity. A heavy tonnage of orders has already been placed for inclusion in the third delivery period which commences on July 1st. There is no doubt that the requirements of firms engaged upon Government work will be met, but to do this it has been necessary further to circumscribe the quantities of material which will be available for ordinary commercial purposes, In the prevailing circumstances the Control have had to scrutinise licences carefully and unless there is some urgent reason why the licence should be issued steel cannot be provided for ordinary purposes. The quietness in the call for heavy joists and structural material is still apparent, but there is an exceedingly active demand for the lighter joists and sections. The re-rolling industry is kept busy by a continual flow of orders, and as they are receiving steady supplies of steel semis production in this section of the industry is upon a heavy scale. It has been indicated that future supplies from abroad may be on a somewhat smaller scale, partly because of the necessity of maintaining a satisfactory exchange position and partly to preserve cargo space. There is a heavy pressure upon the works making plates and heavy and medium sheets. A large proportion of the output goes to the shipyards, which have a huge amount of work in hand, but large tonnages are also being taken up by the tank and boiler-makers. . . . One of the features of the position in the Yorkshire steel industry is the strong demand for special steels, which are wanted in considerable quantities by the armament and munitions makers. The Control carefully supervises the distribution and the period required for delivery to priority consumers has lessened during the past week or two. Another feature of the position in the Sheffield district is the increase which has taken place in the electric furnace production. Practically all the business being transacted comes within the high-priority category, and very little material can be provided for work outside this class.

The Midlands and South Wales

The situation in the Midland iron and steel market is regarded as more satisfactory than for some time. The big home production which has been added to by important arrivals from the United States and Empire countries, has given the producers an opportunity of overtaking some of the arrears which had accumulated. It has been suggested that the position has improved to such an extent that ordinary commercial business may receive more generous treatment by the Control, but so far as can be seen there is little likelihood that either domestic requirements or export trade will be allocated larger supplies than has been possible during the past few months. There has been a considerable improvement in the position of semi-finished materials, and in some cases consumers are holding stocks. It is suggested that the Control will take advantage of this position to reduce imports of this class of steel in order to economise in cargo space. It is likely that the importations of foreign ores will also be reduced. An easier position is noticeable in the constructional steel department, and many works are now in a position to give fairly prompt attention to new orders. The sheet makers also are less pressed than was the case a few weeks ago. In other departments, however, the position has not materially altered. The plate makers are kept extraordinarily busy in filling the requirements of the shipyards and the ship-repairing yards, and there is not likely to be any slackening in this respect. There is a steady and growing demand for many classes of refined steels from the engineering industry. Most of the consuming works are engaged upon war work, and their requirements have high priority. The demand seems likely to continue to expand for a time, and big quantities are passing into use. All the works in South Wales are employed at capacity upon work for the war industries, but the demand for sheets and tin-plates appears to have fallen off somewhat. The call for heavy joists and sections is also quieter but all other descriptions of heavy steel are urgently required.

Copper and Tin

The situation in the copper market shows little change from week to week, and the position in the United States is similar. The consumption in Great Britain is enormous, and is confined almost entirely to the war industries. There have been no complaints of consuming works being unable to obtain their requirements; copper is arriving with regularity, and deliveries, although carefully supervised, are satisfactory. In the United States the authorities have decided that the export figures shall no longer be published. In other respects there has been no particular development in that market. The prices remain unaltered at 12 c. for domestic delivery and nominally at 11 c. for export. Actually there is no export business passing, since licences appear only to be issued in special circumstances, and in any case consumers requiring copper for overseas business would find great difficulty in obtaining the metal. The copper which was recently imported from South America is now being distributed to consumers, and it is understood that in some cases the manufacturers of finished copper materials destined for export have been furnished with supplies. For the time being little export business has been transacted in Great Britain. The demand from India has fallen off, and there has not been much inquiry. . . . Fairly steady conditions have ruled in the tin market of late, and the general view seems to be that no violent fluctuations can be expected for a time. The contango which at one time ruled at £4 has now reacted to about £3 5s., but the position is regarded as healthy. No export licences are being issued and it is not expected that the Government's policy in this respect will be changed for some little time. The intention is thought to be to build up stocks of tin in this country. Consumers, however, most of whom are engaged upon war work, find little difficulty in getting the metal they want. In the United States the position seems sound, and consumption is on a heavy scale. Most of the tin now reaching the United States, however, is coming direct from the Straits, although it is understood that some of the imports reaching America are from the Dutch East Indies. The statistics of tin issued by Mr. W. H. Gartsen give the total visible supply on June 30th as 33,545 tons, compared with 37,191 tons at the end of May. The carry-over at the Straits Settlements was 3095 tons, against 2400 tons on May 31st, and at the European smelters 2351 tons, against 1594 tons at the end of May. Deliveries during June totalled 17,044 tons, compared with 13,944 tons in May.

Lead and Spelter

The lead position in Great Britain remains comfortable and there have been no outstanding developments. Consumption is heavy and is almost entirely absorbed by firms engaged on war work. The situation, however, is sufficiently sound to enable a certain amount of lead to be used by firms making exportable products. In the United States the position remains firm and large tonnages are being used by firms employed on the American defence programme. It is expected in some quarters that the United States Government will purchase foreign metal, as it is suggested that the American domestic supply will scarcely meet the requirements of consumers who are engaged on the rearmament programme. Domestic deliveries in the United States during May totalled 88,000 short tons. . . . Tight conditions continue to rule in the spelter market, and in Great Britain the Control is carefully supervising distribution. It cannot yet be seen what consequences the Russo-German conflict will have upon the spelter position, but it is anticipated that Russia's requirements of spelter will be on a heavy scale. In Great Britain the consuming industries are being carefully catered for by the Control and no complaints are heard of works engaged in the national effort having to go short of metal. In the United States the position also is unchanged. The price remains at 7¼ c., but this quotation applies only to those works engaged on Government work. Other consumers have to pay higher prices. There is no export business passing and there seems little prospect of any metal being available for American overseas trade for a long time to come.

Notes and Memoranda

Rail and Road

SECOND-HAND BUSES AND COACHES.—The Minister of War Transport has made an Order under which it will be an offence as from July 7th to acquire or dispose of a registered omnibus or coach without his authority. In future, any person—dealers included—wishing to buy such a vehicle will have to make an application to a Regional Transport Commissioner for the necessary authority. It is already necessary for persons other than dealers to have a licence to acquire a new or unregistered omnibus or coach.

WOMEN RAIL WORKERS.—There are now over 7000 women workers on the L.M.S. Railway. These women are taking the places of men who are serving with the Forces. Nearly half these women are acting as passenger and goods porters; over 600 are attendants on parcel delivery vans; 246 are employed as labourers at engine sheds; 154 are messengers; and another 109 are engine cleaners. Others are working as stable hands, loaders, checkers, number takers, carters, callers-up, dining car attendants, and tube cleaners.

AMERICAN LOCOMOTIVES FOR EXPORT.—The shipment of railway locomotives from the States in March was eighty-two, as compared with forty-four in February and forty-two in March, 1940, according to reports received from builders by the Bureau of the Census, U.S. Department of Commerce. Shipments for this year's first three months totalled 190 locomotives, as compared with 107 in 1940's first quarter; while unfilled orders at the end of March totalled 645 locomotives, as compared with 139 as of March 31st, 1940.

PULLMAN HOSPITALS.—The U.S.A. Army Medical Corps has converted for Army manœuvres a number of Pullman and "chair" coaches into the "wards" of a railway hospital, to be staffed with three Army nurses and three orderlies, working on eight-hour shifts. The nurses' quarters will be in drawing-rooms at the end of each coach. The hospital trains of ten to fifteen coaches each will contain a kitchen capable of feeding a maximum of 500 persons at one meal. There is also a fully equipped operating room, which will be used for emergency operations, daily dressings, and medical examinations.

RAILWAYS *v.* RIVERS.—Railway interests in America are disturbed over competition from water-borne traffic. An example of traffic losses to barges moving on socialised river channels which the Federal Government built only recently at great expense in connection with the Tennessee Valley Authority is told in the 1940 annual report of the Nashville, Chattanooga and St. Louis Railway Company. The report states that the movement of grain by barge on the Cumberland and Tennessee rivers—which navigation commenced in June, 1939—has continued to grow, with barges moving up the Tennessee as far as Gunterville, Ala., and Chattanooga, Tenn., and up the Cumberland to Nashville. During 1940 a total of 705,000 bushels, or about 470 wagon loads, of corn and oats were barged to Guntersville, and 1,345,000 bushels, approximately 900 wagon loads, to Nashville.

STRAIGHT SECTIONS OF AMERICAN RAILWAYS.—Some data recently collected by the Association of American Railroads reveals that the longest stretch of line without a curve in the United States is the 79 miles on the Seaboard Air Line Railway between Wilmington and Hamlet, North Carolina. Other sections of straight track of 50 miles or over in America are on the Rock Island Lines between Guymon, Oklahoma, and Dalhart, Texas, 72 miles; on the New York, Central, between Air Line Junction, west of Toledo, Ohio, and Butler, Indiana, 68½ miles; on the Monon Railroad between Brookston and Westville, Indiana, 64½ miles; on the Illinois Central Railroad, between Edgewood and Akin Junction, Illinois, 63 miles; on the Atlantic Coast Line Railway, between Waycross and Kinderlou, Georgia, 60 miles; on the Seaboard Air Line Railway, between Okeechobee and West Palm Beach, Florida, 57½ miles; on the Chicago and North-Western Railway, between Vazland and Blunt, South Dakota, 54 miles; on the Denver and Rio Grande Western Railroad, between Villa Grove and Alamosa, Colorado, 53 miles; on the Northern Pacific Railroad, between Fargo and Peak, North Dakota, 51 miles; on the Southern Pacific Railroad, between Tabus and Slater, California, 50 miles. A unique feature of the Denver and Rio Grande Western section of nearly 53 miles, which runs through the San Luis Valley of Colorado, through the heart of the Rocky Mountains, is that it is surrounded by high and rugged ranges. At Alamosa it is 7550ft. above sea level and rises to 7900ft. at Villa Grove; it was built in 1891.

Air and Water

MEXICO TO IMPROVE COAST DEFENCES.—Money for preliminary port military defence works at strategic points along the coasts of Mexico has been voted by the Government. Plans for these works are being developed by the Ministry of National Defence, and the work will be directed by Mexican military engineers and performed by Mexican labour. Ports that are to receive first attention in this programme are at Tampico and Alvaro Obregon on the Gulf of Mexico coast, and Manzanillo and Mazatlan, on the Pacific seaboard.

SWEDISH SHIPPING LOSSES.—Recent reports indicate that during the period January-May sixteen Swedish merchant ships of 67,400 gross tons were sunk through act of war. From the beginning of the war the Swedish shipping losses amount to 122 ships of 307,300 gross tons, of which ninety-six ships of 260,400 gross tons have been sunk, the rest having been seized and condemned by the German prize authorities or held pending their decision. In addition, seven fishing boats have been lost; 741 seamen and passengers have lost their lives in ships sunk by warlike action, 527 being Swedes and 214 foreigners. The majority of the vessels sunk have belonged to that half of the Swedish merchant marine which is employed outside the North Sea blockade. To replace the tonnage losses as far as possible new building is proceeding at Swedish shipyards. The importance of maintaining the volume of the Swedish merchant fleet has been stressed in both Swedish Government and shipping quarters, and measures to this end have been repeatedly discussed. The question was, among other things, dealt with by the Swedish Shipping Convention at Stockholm recently.

SALE OF GOVERNMENT-BUILT SHIPS.—At a meeting of the General Council of British Shipping on July 2nd, further consideration was given to the Ministry of War Transport's scheme for the sale of Government-built ships. Details of the scheme have not yet been disclosed, but the General Council has decided to adopt it in principle and to recommend it to individual owners on the condition that if Allied purchasers are involved, British purchasers shall receive terms no less favourable than those offered to such Allied purchasers.

AMERICAN CARGO SHIPS.—The Moore Dry Dock Company, of Oakland, California, has been awarded a contract by the U.S. Maritime Commission for twelve "C-2" type cargo vessels. The value of the contract is said to be 33,000,000 dollars. In addition to the contract for the new ships, the company has also been granted nearly 1,000,000 dollars for the construction of new slipways, which will be located east of the present ship construction sites. At the time of these awards the Western Pipe and Steel Company, South San Francisco, was granted new contracts for seventeen "C-3" cargo liners.

PORT ORGANISATION.—The Director-General of the Ministry of War Transport has stated that arrangements have already been made at headquarters to unify efforts to secure the quickest turn-round of ships and the Minister of War Transport has now approved the following arrangements at the ports themselves:—In those ports where a Regional Port Director is appointed he is responsible for all the work arising out of the functions and duties of the Ministry relating to the operation of the ports within his region and for these purposes is the Minister's chief executive officer. In matters relating to the loading and discharge of ships he will have the assistance of the Shipping Representative at the ports within the region and, where a Regional Shipping Representative is appointed, the latter will act as shipping adviser to the Regional Port Director. The Regional Shipping Representatives, where appointed, and the Shipping Representative will continue to deal on behalf of the Minister with such matters as the supervision of ships' managers and agents and with questions other than loading (and discharge) which affect ships in port, *e.g.*, crew problems, progress of repairs and arrangements with the naval authorities. The work of the coasting and short sea shipping control committees is unaffected by these arrangements.

Miscellanea

WOOD FOR TELEPHONE LINES.—For what are known as top pins in telephone line construction, Canada has used yellow locust, an imported wood noted for its resistance to decay. Recent work by the Forest Products Laboratories of the Dominion Department of Mines and Resources has shown, however, that Canadian-grown maple, beech and oirch that have been given a preliminary impregnation with creosote oil under pressure, are perfectly satisfactory for this service.

ALUMINIUM PAINT.—It is generally conceded that the value of aluminium paint depends for its durability and covering qualities upon the "flakiness" of its principal content. This has led to experiments designed to produce other pigments with this desirable property. A process for which patent protection is being sought claims that practically any pigment can be manufactured in the form of flakes, thereby assuring for the paint film resistance to the penetration of moisture and corrosive influences.

STREET LIGHTING OVERHEAD WIRES.—The attention of the Electricity Commissioners has been drawn to a case in which a pole carrying low-tension distribution and street lighting wires was damaged by enemy action, with the result that the street lighting circuit became energised and unobscured lamps which had not been removed were lit up. In order to avoid the possibility of this happening in other cases, street lighting authorities are advised that all such lamps not in use should be removed or the fuses removed from individual lamp circuits.

INDUSTRIAL RADIOLOGY GROUP.—The formation of an Industrial Radiology Group, under the auspices of the Institute of Physics, is announced. Its object is to provide a medium for the exchange of information on the practice of radiography and X-ray crystallographic analysis in industry. A committee has been appointed representing those employing X-rays in industry and the manufacturers of industrial X-ray apparatus and films. Membership of the Group will be open to all interested, whether at present members of the Institute of Physics or not. Those interested may register their names with the hon. secretary of the Group, Dr. L. Mullins, A. Inst. P., of the research laboratories, Kodak, Ltd., Harrow, Middlesex, who will send further information as soon as possible.

OIL DRILLING.—The U.S.A. Bureau of Mines has released some information on the use of mud in oil well drilling. Drilling mud, more frequently called "mud fluid" in the oilfields, is used to cool the drilling bit and to prevent oil and gas, under high pressure in the formation, from blowing out of the hole. In its travel to the surface the mud fluid removes drill cuttings from the well, plasters the walls of the hole, thereby preventing caving and the intrusion of water, and conditions the hole in other ways to assure penetration of the bit. Modern drilling fluids are chemical mixtures rather than mud composed of clay and water, but these substances are their most important constituents. The amount of clay used in oil well drilling is great. Some of the clay of special characteristics is sold at a high price per ton.

TWISTED TRANSPARENT TUBES.—An American house has introduced a self-supporting spirally wound transparent acetate tube. This new transparent tube is made by spirally wrapping acetate tape over a steel form of the required diameter inside and using a special acetate cement for the adhesive to ensure a solid non-separating wall. Experience has shown that the tube will not shrink, eliminating one of the difficulties found in extruded acetate tubes. This new product is supplied in continuous lengths of any wall thickness.

B.S.I. AND THE BUILDING TRADES.—Arrangements have been concluded between the British Standards Institution and Mr. T. S. Tait, F.R.I.B.A., the Director of Standardisation of the Ministry of Works and Buildings. The latter has set up a Standardisation Committee with representatives from the various Government Departments, in order to advise him in problems of co-ordinating building requirements. The B.S.I. is represented on this Committee, and the Ministry has decided, as a matter of general policy, that the co-ordinated requirements of the Government Departments in regard to specifications are to be issued through the B.S.I. as British Standard War Emergency Specifications.

Personal and Business

DR. W. CULLEN has been elected President of the Society of Chemical Industry.

MR. E. J. LOWE and Mr. W. Shaw have been appointed local directors of Thomas Firth and John Brown, Ltd.

WE regret to record the death, on July 6th, of Sir Keith Elphinstone, chairman of Elliot Brothers (London), Ltd.

MR. J. R. ROOPER and Colonel D. H. Bates have been elected to the board of the Cunard Steam Ship Company, Ltd.

MR. W. H. DICKINSON, resident engineer at Tyne Dock, is retiring from the Tyne Improvement Commission on account of ill-health.

MR. W. L. NEWNHAM has been appointed Engineer-in-Chief and Under-Secretary of the Public Works Department in New Zealand.

MR. R. G. KINCAID, chairman and managing director of John G. Kincaid and Co., Ltd., has been appointed a director of the Ardrossan Harbour Company.

RADIATION, Ltd., announces that Mr. J. F. Davies has been appointed chairman, in succession to the late Sir C. Herbert Smith. Mr. C. G. Davies has been appointed deputy chairman.

THE LONDON AND NORTH-EASTERN RAILWAY has announced the appointment of Mr. George Mills as divisional general manager, Southern Area, in succession to the late Colonel H. H. Mauldin.

THE STURTEVANT ENGINEERING COMPANY, Ltd., advises us that its London sales office is now at Bush House, Aldwych, W.C.2, and the head office at 25, Worcester Road, Sutton, Surrey.

SIR W. BENTON JONES, chairman of the United Steel Companies, Ltd., has been appointed also managing director in place of Mr. N. H. Rollason, who has resumed his duties as full-time managing director of John Summers and Sons.

WILD-BARFIELD ELECTRIC FURNACES, Ltd., has been appointed by Adam Hilger, Ltd., sole distributor in the United Kingdom to the engineering and metallurgical industries of the Spekker photo-electric absorptiometer, an instrument for chemical analysis by colorimetric methods.

THE LATE MR. R. H. CRIDGE.—We regret to learn that Mr. Ralph Henry Cridge, B.Sc. (Eng.), who was on the staff of the City Engineer's Department of the Corporation of London, died in St. Bartholomew's Hospital on July 1st. He had previously been attached to the staff of the Madras office of the English Electric Company, Ltd.

LORD SOMERS has been elected a director of the Great Western Railway Company. The company also announces the following appointments:—Mr. F. C. Hall as principal assistant to the Chief Mechanical Engineer; Mr. W. N. Pellow as locomotive running superintendent and outdoor assistant to the Chief Mechanical Engineer; and Mr. R. W. Woolacott as assistant to the Chief Mechanical Engineer.

THE Minister of Supply has appointed Mr. W. E. Rootes Deputy Chairman of the Supply Council and Mr. Oliver Lucas Adviser to the Minister on Development and Design, and to be a member of the Supply Council. Mr. S. J. Jackson has been appointed Director of Storage and Transportation to represent the Department of the Controller-General of Transportation of the Ministry in North America.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institution of Civil Engineers

Saturday, July 12th.—YORKSHIRE ASSOC.: Hotel Metropole, Leeds. Luncheon. "The Lennox Road Refuse Disposal Station," W. S. Cameron. 1 p.m.

Staffordshire Iron and Steel Institute

Saturday, July 19th.—Station Hotel, Dudley. "Non-metallic Inclusions in Steel: Quantitative Evaluation," W. H. Hatfield and G. W. Giles; and "Intercrystalline Cracking in Boiler Plates," C. H. Desch. 3.30 p.m.